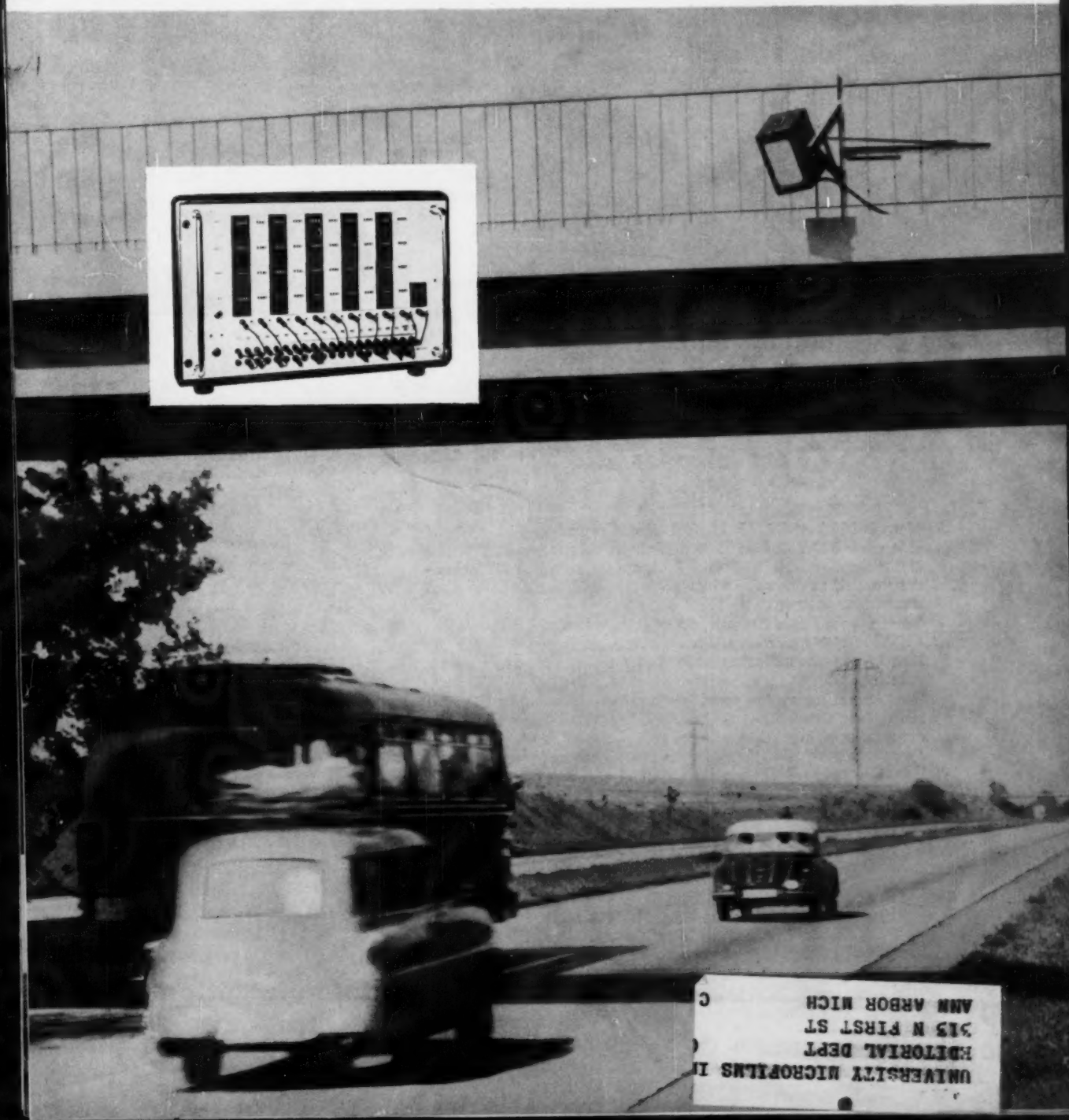
December 9, 1960

electronics

German traffic-counting radar discriminates between motorcycles, automobiles, trucks and truck-trailer combinations. *See p 92*
Level-holding circuits for analog computer memories. *See p 71*

A McGraw-Hill Publication 75 Cents



UNIVERSITY MICROFILMS I
EDITORIAL DEPT
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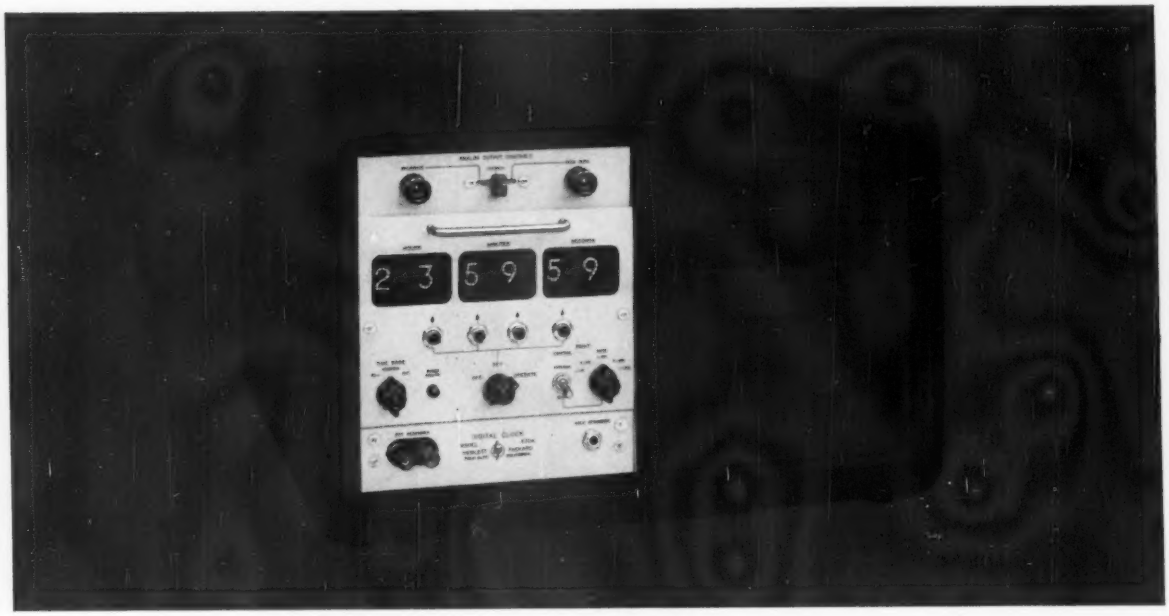
ANN ARBOR MICH

NEW CLOCKS FOR hp DIGITAL RECORDERS



add time-of-day to recorded data
control taking of readings
fit in Digital Recorder cabinet
available for field installation

New hp 570A and 571B Digital Clocks mount in the left-hand side of hp 560A and 561B Digital Recorders, respectively. The clocks may be installed in the field, and fit either in cabinet arrangement, as shown, or into a combined Recorder-Clock rack mount arrangement only 10½" high.

Time appears as a 23 hour, 59 minute, 59 second presentation (12-hour clocks are available on special order). Display is by long-life, in-line indicator tubes. All time digits are available for printing.

Two operating modes provide utmost usefulness. In the first mode, hp or Dymec Digital Counters, Digital Voltmeters or other external equipment control print rate; time being printed simultaneously with other data. In the second mode, for tests where less frequent readings are desired, the Digital Clocks control the timing of readings. A front panel control selects reading rates of 1 per second, 6 per minute, 1 per minute, 6 per hour or 1 per hour.

SPECIFICATIONS

Indication: Six in-line long-life digital display tubes. Indication to 23 hrs., 59 min., 59 sec.

Time Base: Ac line, 1 pps from counter, or external 1 pps.

Accuracy: Time base accuracy + 0, — 1 second.

Print Control: Front panel control selects CLOCK or EXTERNAL control mode. PRINT RATE of 1 sec., 6/min., 1/min., 6/hr., 1/hr. also chosen on front panel control.

Output: Six time digits for time recording. Holdoff signals for hp, Dymec counters.

Power Interruption Alarm: Front panel warning light.

Analog Output: 570A retains analog output of 560A.

Prices: hp 570A (fits hp 560A/AR) $1,050.00; hp 571B (fits hp 561B/BR) $950.00.

Data subject to change without notice.
Prices f.o.b. factory.

HEWLETT-PACKARD COMPANY
1029A Page Mill Road, Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000

HEWLETT-PACKARD S. A.
Rue du Vieux Billard No. 1, Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36

Call your hp representative for demonstration

December 9, 1960

electronics

A McGraw-Hill Publication 75 Cents

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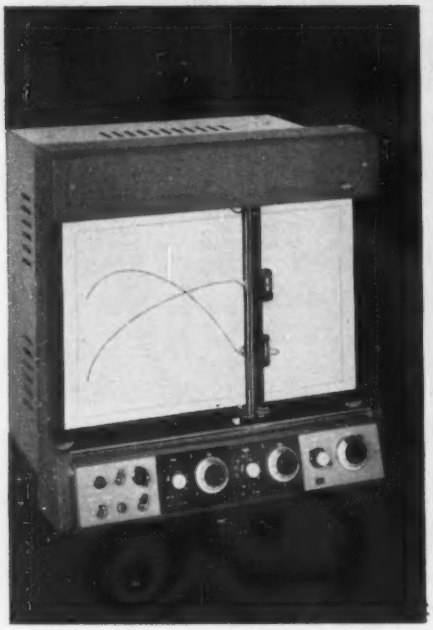
AUTOGRAF AUTOGRAF AUTOGRAF

Moseley 4B AUTOGRAF Recorder

PLOTS TWO DEPENDENT VARIABLES AGAINST SINGLE INDEPENDENT VARIABLE



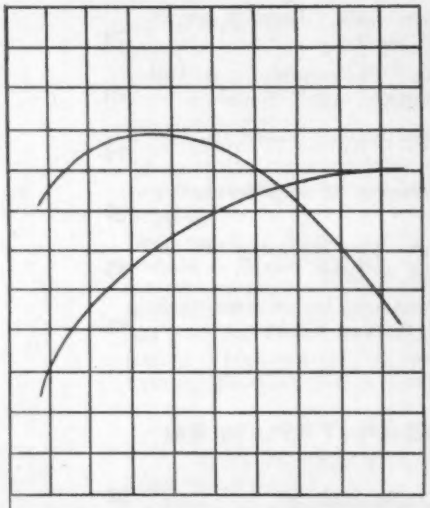
The MOSELEY Model 4B Recorder simultaneously plots two dc input signals against a third signal in cartesian coordinates on standard graph paper.

An internal X-axis time base permits plotting two variables against time.

Three pens are employed; one a fixed pen serving as an event marker to identify significant points during recording. Plotting pens are controlled by independent servos; electrically isolated separate amplifiers eliminate interaction and filters smooth noisy signals for a superior plot.

Model 4B employs either 11" x 17" or 8½" x 11" paper with continuous vacuum hold-down. Transfer switches on range controls permit arbitrary fitting of the voltage to any part of the chart.

The instrument is rack mounted with a vertical recording surface, tilted front control panel, and input connections at the rear.



SPECIFICATIONS

Recording Mechanism:	Independent servo drives for X_1, Y_1, Y_2 axes; free of ground.
Paper Size:	8½" x 11", 11" x 17", vacuum hold.
Recording Speed:	1½" sec on X axis, ½" sec on Y axis for full scale travel.
Input Voltage Ranges:	X axis: 10 ranges, 7.5 mv to 150 v Y axis: 10 ranges, 5 mv to 100 v
Time Intervals:	5 ranges, 7.5 to 750 sec full scale travel (X axis)
Input Resistance:	200,000 ohms/v up to 2 v range; 2 megohms on higher ranges.
Accuracy:	Better than 0.2% full scale. Resetability better than 0.1% full scale.
Power:	115 v, 60 cps, 100 watts. (Other voltages and frequencies to order)
Price:	$3,450.00 f.o.b. factory.

Data and price subject to change without notice.

AUTOGRAF *recorders*

pioneer and leader in X-Y and strip-chart recorders

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CIRCLE 2 ON READER SERVICE CARD

CIRCLE 3 ON READER SERVICE CARD→

WHY THIS IS A BETTER *LATCHING* RELAY

Better? Yes, in several ways. Bifurcated Contacts, for example, give improved reliability, especially in dry circuits. Contacts will not open during vibrations of 30Gs, 55 to 2500 cps. A special method of sealing cover to base eliminates flux contamination of the contacts. And there are more. Here is Potter & Brumfield's newest member of a distinguished family of micro-miniature relays: the FL Series.

Expressly designed for printed circuit applications, this DPDT, 3 amperes (@ 30V DC) latching relay lies parallel to the mounting surface. Its height, when mounted, is only .485", thus circuit boards may be stacked closer. Mounting can usually be accomplished without studs or brackets, simplifying installation.

The FL will remain firmly latched in either armature position without applied power, a significant advantage where power is limited and long relay "on" times are required. This relay may be operated by:

1. Pulsing each coil alternately (observing coil polarity), or
2. Connecting the coils in series and operating from a reversing (polarized) source.

Write for complete information or call your nearest P&B representative.

FL SERIES SPECIFICATIONS

Shock: 100 Gs for 11 milliseconds. No contact openings.

Vibration: .195", no contact openings. 10 to 55 cps. 30 Gs from 55 to 2500 cps.

Pull-In: 150 milliwatts maximum (standard) at 25° C. 80 milliwatts maximum (special) at 25° C.

Operate Time: 3 milliseconds maximum at nominal voltage at 25° C.

Transfer Time: 0.5 millisecond maximum at nominal voltage at 25° C.

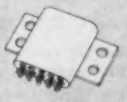
Temperature Range: −65° C to +125° C.

Terminals: Plug-in pins.

Dimensions: L. 1.100" Max.—W. .925" Max H. .485" Max. Hermetically sealed only.

SC 11 D

SCG 11 DC



SL 11 DB
(Latching)

SLG 11 DA
(Latching)

Other P&B micro-miniature relays include conventional and latching models in crystal cases with a wide range of terminals and mountings. All are made in a near-surgically clean production area under the exacting requirements of our intensified Control and Reliability program.

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electronics
Dec. 9, 1960 Volume 33 Number 50

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CROSSTALK

SINCE WORLD WAR II, many corporations, as well as military commands, have grown to empire proportions. In the electronics industry this growth denotes great business potential, but it is also a headache.

The headache is how to manage such vast and complex operations.

The military and industry are approaching the problem in opposite ways. The military is following its traditional concept, strong central control. Industry, on the other hand, is attacking it by decentralization into separate, almost autonomous departments.

Both concepts are paying dividends. Giant corporations that have become almost principalities are doing well. And criticism of our defense effort seldom includes criticism of the military's desire for unified control.

Which concept will pay off best in the end? When does the law of diminishing returns take over? And which concept will it upset? Industry is the one headed for trouble, according to M. O. Kappler, president of Systems Development Corporation. He told the Aerospace Writers Assoc. in New York recently: "Division of a company into a number of small—and at times competitive—businesses results in waste of manpower, plant space, capital investment and potential business."

The best way for a corporation to make the most of its possibilities, Kappler said, is to maintain efficient central control. To achieve this, however, an omniscience is called for that may not be possible with conventional techniques. Even the board of directors may not be able to digest all the information trickling in from remote plants.

Big industry needs systems for acquiring information, and processing and presenting it, similar to the military's electronic command control systems. Data would be fed periodically into terminal communications equipment at the various plants and departments, automatically transmitted to headquarters, and stored in computers. By pushing a button, lists, charts, and answers to specific questions could be found and displayed.

Such systems cost money. The Air Force talks about $20 billion worth of command control systems it would like to have. The other services have similar admiration for automatic information systems and run up equally unattainable requirement lists.

USAF already has in operation the continental air defense system SAGE, and SACCS, the Strategic Air Command Control System, is under development. Estimate to date for SACCS is about $270 million. Obviously, industry can not pay such prices. Kappler believes, however, electronic communications, data-processing and display systems can be developed for industry for a more reasonable price. He also believes such a changeover is inevitable. "It will require a whole new concept of management," he says.

Coming In Our December 16 Issue

STEREO. Requirements for the transmission of sterophonic sound by the aural transmitter of a tv broadcast station differ somewhat from those for either f-m or broadcast-band a-m stereophony. This is because tv receivers contain intense potentials at the horizontal sweep frequency and its harmonics. Stereo information must, therefore, be carefully placed in the frequency spectrum to avoid the deleterious effects in the reproduced sound due to interference from the sweep frequencies.

In our next issue, R. B. Dome of General Electric Co. in Syracuse describes a method of compatible stereophony specially designed for tv broadcasting. A novel pilot frequency arrangement regenerates the double-sideband suppressed subcarrier. Only one triode is used in the receiver demultiplexer.

IN ADDITION. The variety of interesting feature articles to appear next week includes: a tape recorder for programming engine dynamometer tests by V. C. Vanderbilt, Jr. and C. L. Zimmer of Perfect Circle Corp.; a digital converter for analyzing electroencephalograms by Dr. M. G. Saunders of Winnipeg General Hospital and the University of Manitoba; gas clipper tubes for radar modulators by W. W. Watrous and J. McArtney of Tung-Sol Electric; and a method for measuring high-frequency transistor admittance parameters by K. Redmond of Amperex Electronic Co.

CIRCLE 5 ON READER SERVICE CARD→

Raytheon Cathode Ray Tubes Operate at 100,000 feet without Corona

The Raytheon CK1354 and CK1355 display cathode ray tubes, used in the SAC "Hustler," are designed to operate in unpressurized areas of aircraft at altitudes up to 100,000 feet without corona. The CK1354, a three inch tube, is used for photographic purposes and the seven inch CK1355 is used in a direct visual application. Quick disconnect features eliminate potting of high voltage terminals and allow rapid replacement.

Both tubes are designed to meet exacting mechanical dimensions for rotating deflection yoke assemblies, and the high altitude requirements of Mil-I-6181-B.

If the development of airborne radar equipment is currently of interest to you, then investigate the many advantages offered by these remarkable tubes. Also inquire about the other types of industrial and military cathode ray tubes in Raytheon's comprehensive line.

For technical information or design assistance please write to Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

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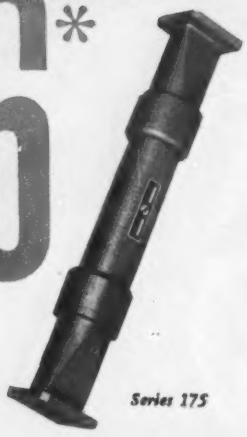
FXR's FIXED PRECISION ATTENUATORS

6*



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- OPERATION: Full waveguide bandwidth
- WAVEGUIDE RANGE: 2.6 KMc to 90.00 KMc
- Values factory set between 0.3 and 30.00 db
- Absolute accuracy (including frequency sensitivity)
  ±0.3 db for values to 20 db
  ±0.5 db for values 20 to 30 db
- VSWR: 1.15 max

*

No. 6 of a series of FXR's new precision microwave components designed to meet the ever-growing needs of the microwave industry.

FXR's Fixed Precision Attenuators find use in standardizing the testing of attenuators, directional couplers and similar instruments in the laboratory or on the production line. Attenuation values are almost completely determined by the angular position of an attenuation film in a cylindrical waveguide and are insensitive to frequency or the characteristics of this absorbing film.

MODEL NO.	FREQUENCY RANGE KMc	WAVEGUIDE TYPE RG-( )/U	PRICE
S175A	2.60–3.95	48	$365.00
H175A	3.95–5.85	49	240.00
C175A	5.85–8.20	50	135.00
W175A	7.05-10.00	51	115.00
X175A	8.20-12.40	52	95.00
Y175A	12.40-18.00	91	115.00
K175A, AF	18.00-26.50	53	240.00
U175A, AF	26.50-40.00	96	250.00
Q175A	33.00-50.00	97	475.00
M175A	50.00-75.00	98	425.00
E175A	60.00-90.00	99	675.00

Write for Catalog Sheet No. 175

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COMMENT

Ions and Health

I have been much interested in your report on air ionization and in the subsequent comment (see "Ions Affect Health, Behavior," p 45, Feb. 26, and Comment in various following issues, including p 6, Nov. 11). Since you have gone so far as to accept some of the more startling conclusions of the researchers pertaining to the effects on humans, I trust you will be prepared to defend those conclusions.

Some eight or ten years ago, I conducted extensive spare-time experimentation with the production and measurement of ionization in indoor air. When I tried the effects of negative ionization on myself and friends, I was unable to observe any of the many beneficial effects that were even in those days being promised. Which proves nothing, of course.

But there are questions which will occur to any thoughtful worker in electronics before he arranges to breathe only negative air. Perhaps the latest experimentation has already given the answers to such questions. All the more reason why another and more detailed report in ELECTRONICS would be heartily welcomed, which could deal with such questions as:

Are we to believe that man's natural habitat, the outdoors, is unhealthful for him? The entire surface of the earth (with the exception of those portions where thunderstorms are in progress) is continually subject to a heavy rain of positive ions. Accordingly, the natural condition of the outdoor air is positive, not negative. This being the case, how is it that natural selection over the ages has not rendered us immune to the harmful effects?

What about examples of unfavorable effects from negative ionization? Isn't it true that arthritis sufferers are apt to feel aches in their joints just prior to thunderstorms, when negative ionization is at its greatest? Isn't it also true that many arthritis sufferers find relief through living on the desert, where the air is positive nearly all the time? I can add the incidental information that a certain manufacturer of air purifiers, which produce heavy negative ionization, has had to take back quite a few units from purchasers who actually appear to be allergic to the effects.

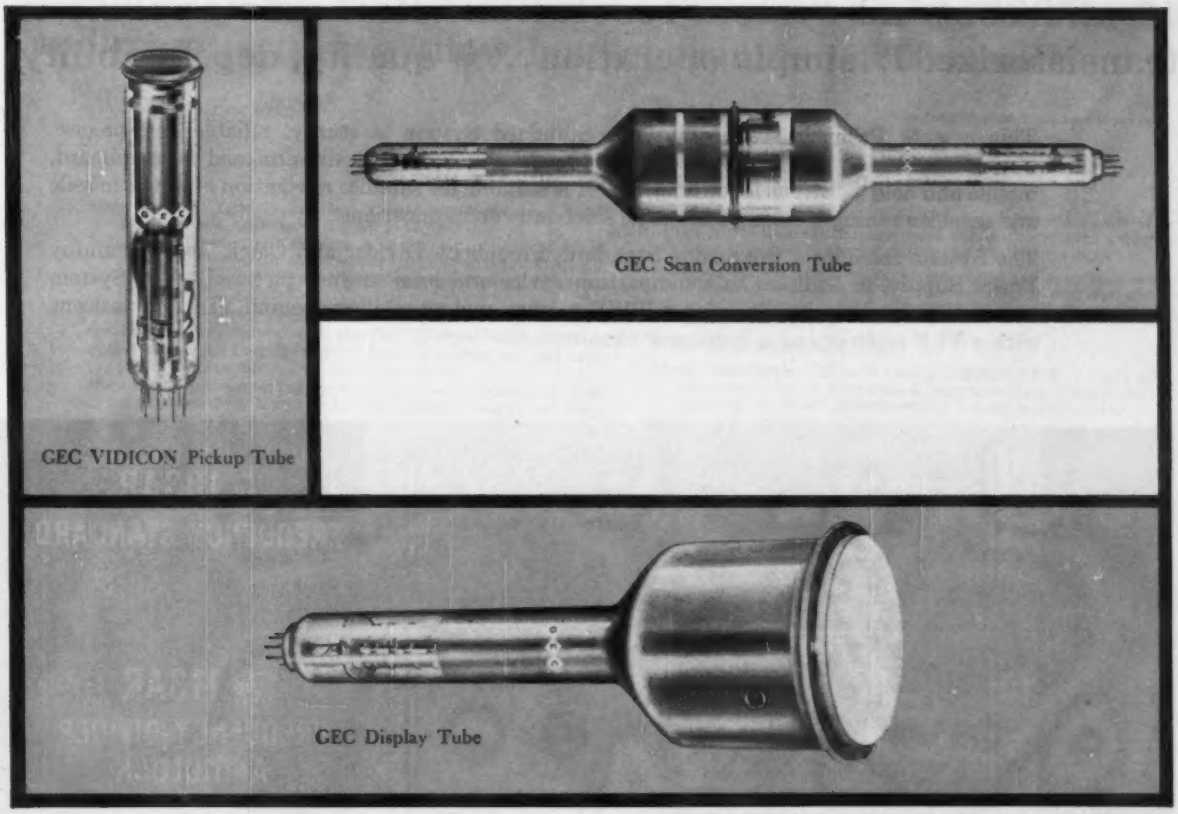
Has dust been completely ruled out as a factor in the physiological results claimed? It is at least possible that the observed results flow, not directly from the ionization, but from the effects of the ionization on house dust, to which it is known that many of us are allergic. Note in this connection that it is said that in the most healthful locations in the world (Baden-Baden, Altadena, and so forth), dust behaves in unusual fashion; it appears to settle upwards instead of downwards. . . .

WARNER CLEMENTS
BEVERLY HILLS, CALIF.

All right, let's take the points one at a time. First, we do not accept— in the sense of espouse— research results; we report them. Second, we agree that reader Clements' indecisive experiment proves nothing. Third, no one has ever suggested that people should breath only "negative air;" what has been demonstrated is that a slightly negative balance of ionization is desirable. Fourth, the natural condition of fresh outdoor air is slightly negative, due, among other causes, to the ionizing effect of sunshine; consequently, natural selection has made man to be at his best in this ambient. Fifth, people feel greater discomfort just priof to thunderstorms because this is when positive ionization is at its peak; the thunderstorm restores the balance, renders the air slightly negative. Arthritis sufferers probably react to other characteristics of the ambient, such as humidity and atmospheric pressure.

Sixth, no doubt there are people who are allergic to heavy negative ionization, as there are probably people allergic to slight negative ionization; there are, after all, even people who are allergic to sunlight. This doesn't interfere with general deductions from observed data as far as the statistical norm is concerned. Seventh, dust has not been ruled out; most air-ionizers remove it too, and most behavioral research takes dust into consideration.

G E C ....WHERE TUBE RESEARCH BEGINS



Research at GEC has been playing an important role in the advancement of pickup, transformation and visual display tubes. GEC is pioneering further in development of pickup tubes sensitive to all parts of the spectrum, particularly near and far infrared. Continuing research in high resolution pickup, conversion and display tubes is a major activity in GEC's development program. General Electrodynamics Corporation has demonstrated its ability in successful mass production of high sensitivity vidicons, and results of continuing research in this field will soon be available to industry.

If your project is being held up by a tube that doesn't exist, contact GEC .... *where tube research begins.*

G E C **GENERAL ELECTRODYNAMICS CORPORATION**

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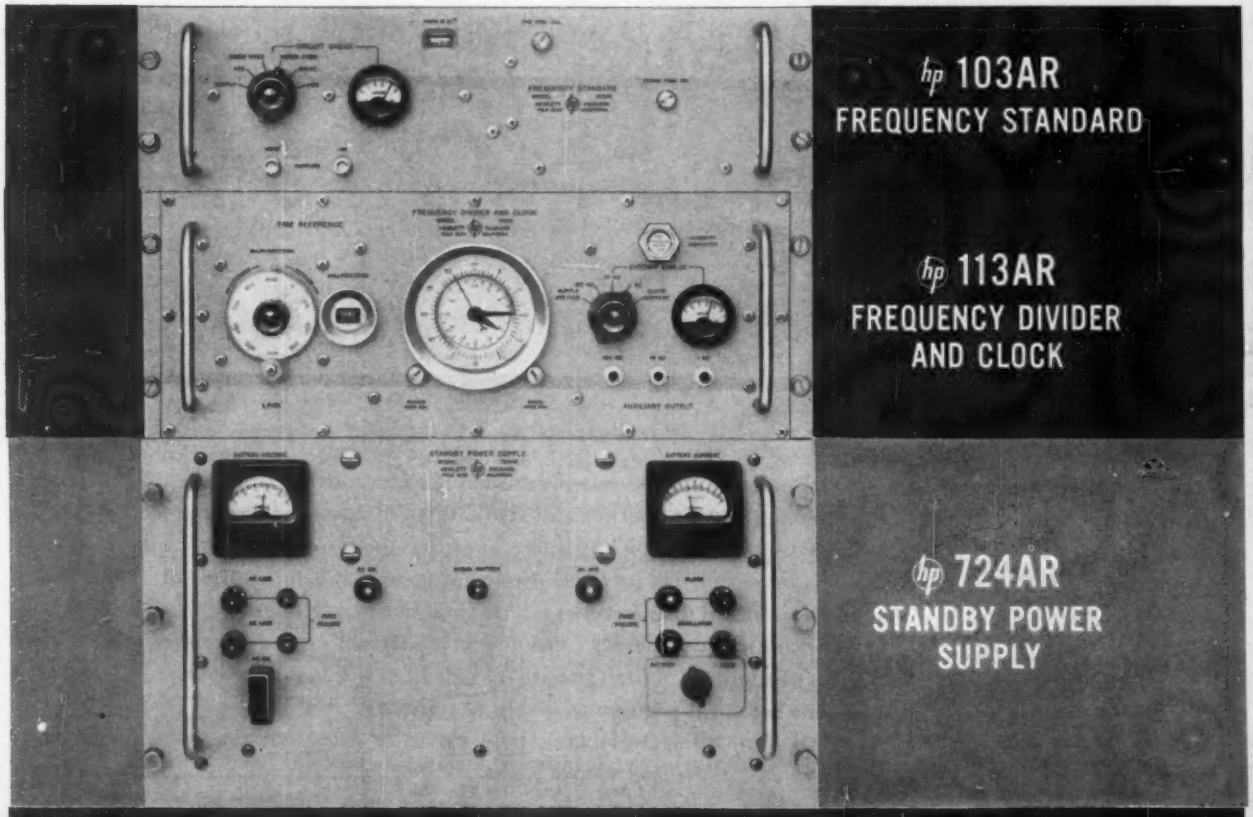
NEW hp PRIMARY FREQUENCY & YOU THE HIGHEST ACCURACY,

5 parts in 10^{10}/day long term stability...1 part in 10^{10} 10 microsecond system resolution...fail-safe operation transistorized...simple operation... hp quality, dependability

This new hp Primary Frequency/Time Standard System is sturdy, reliable and precise. Featuring compact design and low power operation, it is specifically designed for shipboard, mobile and field as well as laboratory use. It is suitable for satellite navigation systems, missile and satellite timing-tracking and single sideband communications.

The System includes a Frequency Standard, Frequency Divider and Clock, and a Standby Power Supply, in addition to a comparison device and receiver (not pictured). The System makes HF time comparisons with a WWV receiver and an oscilloscope and VLF comparisons with a VLF receiver and a frequency counter.



hp 103AR
FREQUENCY STANDARD

hp 113AR
FREQUENCY DIVIDER
AND CLOCK

hp 724AR
STANDBY POWER
SUPPLY

Write direct or call your hp representative today for detailed information on

TIME STANDARD SYSTEM OFFERS RELIABILITY & SPECTRAL PURITY

typical short term stability under laboratory conditions*... despite power interruption . . . compact design (23" high), and manufacturing know-how guarantee performance.

***Averaged over 1 second intervals.**

hp 103AR Frequency Standard—Specifications

Stability: Short Term: Better than 5 parts in 10^{10} averaged over 1 sec. intervals. Long Term: 5 parts in 10^{10} per day.

Output Frequencies: 1) 1 MC sine waves, 1 volt rms into 50 ohms; 2) 100 KC sine waves, 1 volt rms into 50 ohms; 3) 100 KC output for driving hp 113AR Frequency Divider and Clock, 0.5 volt rms minimum into 300 ohms.

Harmonic Distortion: > 40 db below rated output.

Non-Harmonically Related Output: > 80 db below rated output.

Output Terminals: Outputs 1 and 2: BNC connectors on front panel and at rear. Output 3: BNC connector at rear.

Frequency Adjustments: Coarse: Screwdriver adjustment with range of approximately 1 part in 10^8. Accessible through front panel by removing threaded plug.

Fine: Front panel control with range of approximately 600 parts in 10^{10}. Accessible through front panel by removing threaded plug. Digital indicator calibrated directly in parts in 10^{10}.

Monitor Meter: Ruggedized front-panel meter and associated selector switch monitors: 1) SUPPLY voltage; 2) AGC voltage; 3) INNER OVEN current; 4) OUTER OVEN current; 5) 100 KC output; 6) 1 MC output.

Temperature Range: 0-50°C.

Power Requirement: 22 to 30 volts dc, approximately 5 watts after warmup at room temperature. Approximately 9 watts during warmup. hp 724AR Standby Power Supply recommended.

Price: Model 103AR $2,500.00

hp 113AR Frequency Divider and Clock—Specifications

Uses a directly calibrated precision resolver as a time reference control, plus unique jitter-free optical gating system. Clock is fail-safe, incorporates regenerative dividers insuring neither gain nor loss of time with respect to driving oscillator.

Frequency Input: 100 KC for solar time, input bandwidth is ± 300 cps. 100.3 KC for sidereal time, on special order.

Accuracy: 1) Accuracy of output pulse and sine-wave signals determined by accuracy of input frequency. 2) Time reference dial accuracy ± 10 μsec.

Effect of Transients: hp 113AR will not gain or lose time because of 1) ± 300 volt step function on 100 KC input; 2) 0 to ± 50 volt pulses, 0 to 500 pps, 1 to 10 μsec duration on 100 KC input; 3) ± 4 volt step in 26 vdc input.

Voltage Input: 0.5 to 5 volts rms.

Input Impedance: 300 ohms nominal.

Tick Output:		
	Pulse Rate	1 pps
	Jitter	Less than 1μsec
	Amplitude	10 volts minimum, negative
	Rise Time	Less than 10 μsec
	Duration	5 to 30 μsec
	Source Impedance	5 K ohms nominal

1 KC Pulse:		
	Pulse Rate	1,000 pps
	Amplitude	+ and — pulses, at least 4 volts peak
	Duration	8 μsec nominal
	Source Impedance	5 K ohms nominal

Time Reference: Continuously adjustable. Directly calibrated in millisecond and 10 microsecond increments.

Auxiliary Output: 100, 10, and 1 KC sinusoidal, 0.25 volt rms, source impedance 1.2 K ohms.

Frequency Divider: Regenerative type, fail-safe (non-selfstarting).

Clock: 24 hour dial; minute hand adjustable, in 1 minute steps; second hand continuously adjustable, manual start. Front panel adjustment of clock hands does not affect tick output. 12 hour dial on special order.

Monitor Meter: Ruggedized meter and selector switch on front panel for checking SUPPLY VOLTAGE, divider current (100 KC, 10 KC, 1 KC) and CLOCK CURRENT.

Power Required: 22 to 28 volts dc, 10 to 25 watts depending on operating conditions. Powered by hp 724AR.

Price: Model 113AR, $2,500.00

hp 724AR Standby Power Supply

Powers hp 103AR and hp 113AR and is used with lead-acid or long-life alkaline standby battery which "floats" across regulated power supply, instantly assumes load without switching in case of ac power failure, continues system operation up to 24 hours. Additional power supplies can be furnished for longer and shorter standby capabilities. Regulator current automatically limited at 2.5 amperes. Built-in alarm circuits have front-panel indications, provisions for remote alarm. When ac line power is restored after interruption, battery is recharged. Power, 115 v ac, 60 cps, approx. 100 watts max. hp Model 724AR, $750.00 with 20 ampere-hour alkaline battery, $450.00 without battery.

Additional equipment for basic system. Oscilloscope, receiver for HF comparisons; counter, receiver for VLF comparisons. **Equipment for special requirements.** hp 114AR Time Comparator, hp electronic counters, frequency dividers, etc.

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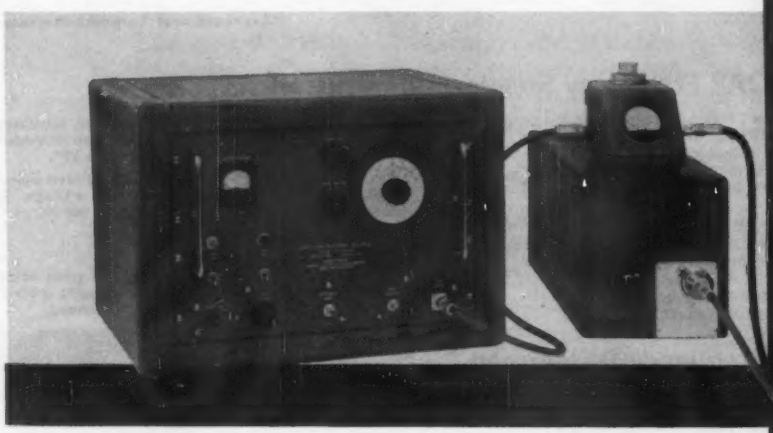
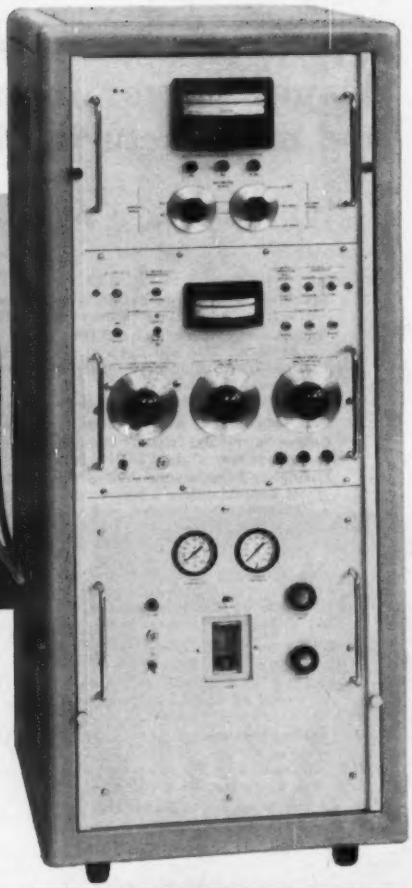
Primary standard accuracy for power measurements to 1,000 watts!





Sierra 290B Test Set

Frequency coverage dc through 12.4 KMC.

Guaranteed power measuring accuracy of 1%. Probable accuracy better than 0.5%. Precise ac wattmeter, calorimeter and heat exchanger in one neat, rack unit. Separate dual loads for dc to 4 KMC, also C, XB, X bands. Direct reading linear scale.

Above are highlights of the new Sierra 290B Calorimetric Wattmeter Test Set—the industry's closest approach to absolute power measurements in this range.

Model 290B measures power in three distinct modes.

1. For power levels 30 to 1,000 watts, a null-balance mode provides measurement accuracies of 1% or better, with probable error as low as 0.5%.

2. For wider range power levels from 10 to 1,500 watts, a direct-reading mode provides excellent linearity in thermal readout and 2% to 3% accuracy. Readout is fast—60 seconds or less.

3. For expanded scale readings of highest resolution, the above two modes may be combined in a third mode to obtain the order of accuracy of the null-balance mode, together with the time-saving convenience of the direct readout mode.

Model 290B, $4,500.00. (Water loads, extra.)

Data and prices subject to change without notice. Prices f.o.b. factory.

Laboratory setup above shows Sierra Model 215 Power Source being used in conjunction with Model 290B Calorimeter to calibrate Sierra Bi-Directional Power Monitor. Designed specifically for calibration purposes, 215 series Sources include four 50 watt models covering, collectively, 25 to 1,000 MC. Model 215A, 25 to 50 MC; Model 215B, 50 to 150 MC; Model 215C, 150 to 470 MC; Model 215D, 470 to 1,000 MC. Price (any model) $3,300.00.

For complete details, see your Sierra representative or write direct

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ELECTRONICS NEWSLETTER

Components Leveled Off During Second Quarter

SHIPMENTS of electronic components for the second quarter of 1960 remained at the first-quarter level, according to Commerce Department's Business & Defense Services Administration.

There was no increase in overall output of semiconductors; a decline in transistor shipments was counterbalanced by increases in shipments of solid-state diodes and rectifiers. Capacitors, connectors and receiving tubes declined slightly; power tubes, special-purpose tubes, tv picture tubes, transformer and quartz crystals registered small advances.

Metal-Insulator Mixtures May Aid Cryo Development

CRYOGENIC researchers at A. D. Little and other laboratories report the development of materials with extraordinarily low thermal conductivity. New materials are expected to significantly reduce the cost and complexity of field systems using supercooled circuits.

In effect, a large number of thermally isolated radiation shields are used to reduce radiation losses. Mixtures of insulating and metallic powders—silica powder mixed with aluminum powder, for example—can simulate a large number of such shields. Among materials of low conductivity being investigated are glass or plastic beads, nylon mesh, glass-fiber paper, quartz sand, crushed glass, glassfoam, Mylar. Double-walled containers with evacuated interspace will still be needed for maximum thermal insulation.

Plan to Supplement Space-Probe Antennas

CALTECH's Jet Propulsion Laboratory is now studying proposals to supplement the 85-ft tracking antennas at its deep-space instrumentation facilities with 250-ft units. If any of the proposals prove feasible, the first large-aperture low-noise advanced system will be working at Goldstone, Calif., by Spring of 1964. Other sites involved are Woomera, Australia, and Krugersdorp in the Union of South Africa.

Communications capability of the facilities will be increased by a factor of between 10 and 30. Cost of these antenna systems, JPL figures, increases as the diameter to the 2.7 power. The lab will consider any proposal that increases communications capability ten times and costs less than $10 million per installation; project will be scrubbed if the figures aren't approached.

USAF Researching Tactile Communications

SUPPLEMENTARY communications channel using "Helen Keller" techniques to overcome noisy environments may develop from studies being undertaken by the Air Force.

Psychologists at Rome Air Development Center figure that processed speech can be received by tactile means through the skin. Rome ADC researchers have reported that the vibratory response of the skin offers a supplementary channel with a good data rate, high flexibility, and small training requirements.

Tactile reception would be noiseless, might therefore be useful where transmission of sound is undesirable—as in a forward infantry outpost.

Soviet Union Pushes Solid-State Research

SOVIET research in solid-state physics is growing so fast that the rate of publication in this field may pass the U. S. rate in 5 to 10 years. This conclusion was reached by an unidentified federal agency from evaluation of available data; study was released by Commerce Department.

Theory is the prominent feature of present Soviet work, the report says, adding: "The best workers are extremely prolific and versatile and seem unburdened by administrative and teaching duties." In the areas of solar cells, diodes and piezoelectricity, "Soviet experimental research is of the same level as comparable U. S. research."

The report also points out that cooperation between theoretical and experimental researchers is not so close as in the U. S. Electron optics, thermoelectricity and other traditional studies are being emphasized, while such new areas as nuclear resonance phenomena are not receiving the same attention in the USSR as in the U. S.

Japan to Stress Frequency Meters

JAPAN's Ministry of International Trade & Industry will next year promote the production of frequency meters and stimulate production of connectors and electrodes for pH meters. MITI action is in accordance with industry promotion legislation, involves a higher standard of quality and performance at lowered prices.

Signal generators, microwave meters, color-tv test instruments are currently being imported into Japan at a rate that displeases MITI. The ministry will establish standard specifications, set up national and organizational ratings, promote the development of domestic production in order to cut these imports.

MITI estimates demand for connectors in fiscal 1961 (the Tokyo government's fiscal year ends in March) at $4.5 million, to rise to $7.5 million in fiscal 1963. Production costs are to drop in fiscal 1962 to 80 percent of last year's level. Demand for pH-meter electrodes is estimated at 58,500 units for about $440,000 this year; next year it is to rise to 82,500 units at $550,000, and by 1963 it should hit 166,000 units for $835,000.

Military to Forecast Component Requirements

ARMED SERVICES have agreed to forecast requirements in 13 categories of electronic components on a five-year basis, the Electronics Production Resources Agency announced in San Francisco last week. First five-year forecast will be ready next July.

Forecast will cover three types of batteries; seven kinds each of capacitors and resistors; all types of transformers and inductors; five types of electrical indicating instru-

ments; three types of relays; three types of quartz crystals and filters; and all types of connectors and servo devices.

Requirements of four types of receiving tubes, 13 types of power and special-purpose tubes, four types of semiconductor diodes and two types of transistors will also be forecast. The services have also tentatively approved a list of components in six categories that will be reported on an 18-month projection, with first publication due in January 1962. Capacitors, resistors, transformers, relays, connectors and instruments are included in the latter schedule.

Aircraft Position Display Uses Vortac Outputs

VORTAC display device developed by ITT Laboratories and announced last week gives aircraft pilots continuous indication of aircraft position over the ground.

Bearing and distance voltages from the Vortac receiver are amplified to drive two transparent faceplates. One contains a bearing cursor which gives the aircraft's course. The other contains an Archimedean spiral, which intercepts the bearing cursor at the correct range from the Vortac ground station. Intersection point is aircraft position. Air-navigation charts centered on ground-station sites are used as underlays for the two faceplates, can be quickly change.

Transistor amplifier to step up the Vortac outputs in order to drive the faceplates is self-contained in the display unit. Circular display is 12 in. in diameter. Device eliminates the necessity for manual plotting of navigation data.

Engineer Builds Pinhead Motor

A YEAR AGO, a theoretical physicist at CalTech offered $1,000 to "the first guy who makes an operating electrical motor that can be controlled from the outside, that will be only a sixty-fourth of an inch cube not counting the lead-in wires."

Last week, electronics engineer W. McLellan of Pasadena, Calif., copped the prize with a motor 0.006 in. in diameter that puts out a millionth of a horsepower. The four coils of its stator have 21 turns each; the device uses a quartz bearing. It took McLellan 2½ months to build the motor; he had to display it under a 40-power microscope.

Concrete Toroid Houses Zero-Gradient Synchrotron

CONCRETE doughnut 210 ft wide now rising 25 miles southwest of Chicago has an 88-ft-wide central cylinder to house major components of one of world's biggest zero-gradient proton synchrotrons.

The synchrotron will cost $42-million, will be completed in 1962. It will produce all 30 presently-known or anticipated subatomic particles.

Toroidal structure will enclose a 5,000-ton ring of eight steel magnet sections. Hollow rectangular centers at near-perfect vacuum will form 200-ft-wide raceway to accelerate protons. Magnetic field will guide protons around circular course, while building up acceleration energies to some 12.5 billion electron-volts before they're crashed into target atoms.

Central cylinder will house 144 mercury arc rectifiers feeding 15 one-second pulses of direct current every minute at maximums of 11,000 amps or 12,500 volts into several miles of heavy hollow copper wire in the magnet sections.

Develop Low-Power Recorder For Satellite Use

TINY reel-to-reel magnetic recorder-reproducer has been developed by Consolidated Electrodynamics for missile and space applications. Device operates on principles similar to those used in Courier's recorder. Power requirement is "considerably less" than one watt, compared with the 10-w load of the Courier unit.

Recorder can hold 95 minutes worth of data, recording at one inch a second; playback is at 18 in. a second. Unit carries 750 ft of quarter-inch tape, uses coaxially mounted counter-rotating reels, weighs 4 lb, occupies 200 cu in. of volume.

Switch Handles Million Amperes

PLASMA DYNAMICS and shock-wave research caused Boeing to develop a switch that can handle a million amperes at 100 Kv. A second unit now abuilding will be able to handle the same currents at 200 Kv.

Switch is housed in an evacuated cylinder, is made up of 27 circular steel plates 6 in. in diameter separated by Teflon spacers and encased in polyethylene. Voltage between neighboring plates is only 4,000 v. Vacuum is maintained at about 50 microns Hg. The switch discharges a bank of capacitors into metal foil contained in a test cell. Energy in the bank of capacitors is fed into one end of the switch on a plasma created by discharging a single 20-Kv capacitor through a fine tungsten wire; thermionic effect relays the power across the array of steel plates.

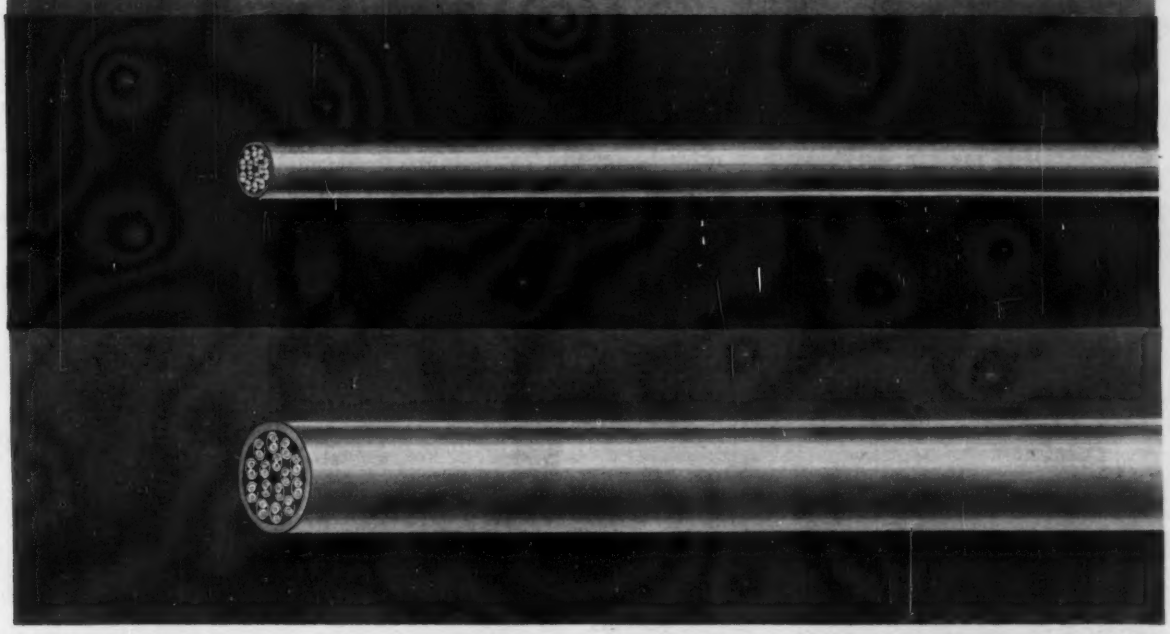
Code-Translation Data System Wins Navy Backing

NAVY is reportedly recommending code-translation data system, first used on the Gulf missile range and the Atlantic missile range extension, for any new communications links requiring high reliability. Automatic error-checking feature of the Hallicrafters-developed system is said to provide 99.999-percent reliability.

Synchronizing and timing signals are converted into serial phase-modulated signal for transmission, later reconverted to three parallel signals at the receiving point. Parallel digital data signals contribute to the system's transmission economy.

Closed-loop transmission uses both sidebands in single-sideband transmission link. Signal originally transmitted over one sideband is fed back over the other for error checking. Hallicrafters spokesmen claim CTDS is compatible with wire communication and tropospheric scatter systems as well as standard and ssb radio communications.

Which cable has the **Beldfoil*?**

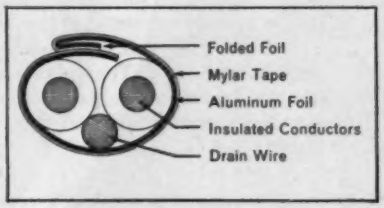


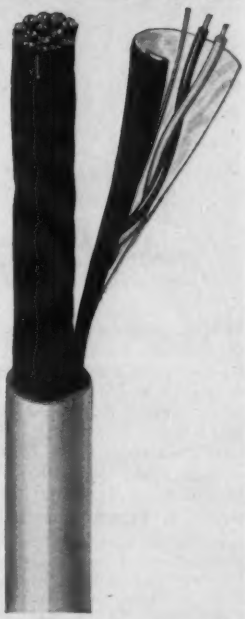
Both shielded cables have the same number of twisted pairs with identical AWG. But . . . the cable with exclusive Belden BELDFOIL is smaller in diameter.

What does this mean to you? It means that when you specify BELDFOIL, you are really buying extra space—extra conduit space, extra raceway space, extra console and rack space.

A new development by Belden—BELDFOIL shielding is 100% effective. It is a major development in quiet cables. BELDFOIL eliminates crosstalk and is superior for stationary or limited flexing at both audio and radio frequencies.

BELDFOIL shielding is a lamination of aluminum foil with Mylar which provides a high dielectric strength insulation that is lighter in weight, requires less space, and is usually lower in cost. For multiple-paired cables, with each pair separately shielded, the Mylar is applied *outside* with an *inward* folded edge.** This gives 100% isolation between shields and adjacent pairs.





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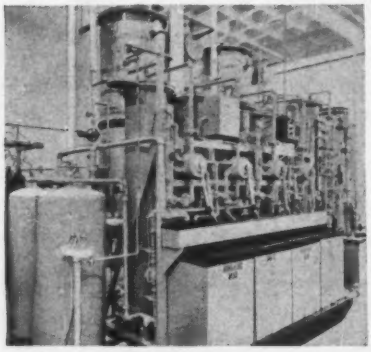
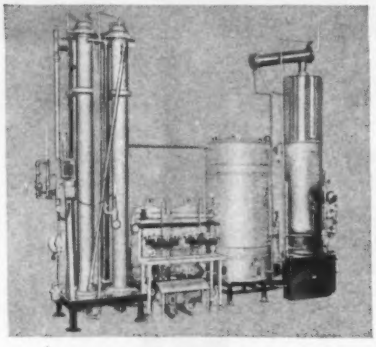


PHILCO'S Lansdale Tube Division uses this Water Purification "Train" equipment in processing components. Costs are reduced as most of the process water is repurified and fed back to the system for re-use. Barnstead equipment includes a 20 GPH High Purity Still, 150 gallon heated ultra-violet equipped tank to prevent growth of bacteria, two BD-10 Holders with special high purity Supercartridges®, an MF-200 Submicron® Filter, and heat exchanger. Barnstead makes water versatile.



IBM installation . . . at Poughkeepsie, New York, produces 200 gallons of extremely pure water per hour, 18 megohms resistance at 25° C. and free of all types of impurities. Equipment consists of Sand and Carbon Filters, Four-Bed Demineralizer, Two High Purity Stills, 1000 gallon storage tank, Mixed-Bed Demineralizer, Submicron Filter, and Heat Exchanger.

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WASHINGTON OUTLOOK

KENNEDY ADMINISTRATION'S official attitude on political and economic issues of concern to the electronics industry is beginning to take shape. The situation on defense and space has already been discussed in these columns. On other matters—tax depreciation allowances, labor legislation, foreign trade policy, minimum wage, stimulation of the economy—there's one clear warning: don't expect any radical shakeup. Despite press reports, there will be no sweeping overhaul like Franklin D. Roosevelt's first hundred days.

Kennedy favors a more liberal tax policy for depreciation of capital plant and equipment. This would aid electronics producers expanding or modernizing their facilities, and would spur the market for numerical controls such as are incorporated in newer machine tools and other metal-working machinery.

Word from sources close to the President-designate indicates that his foreign trade approach will be more liberal than Eisenhower's. These advisers discount campaign statements that certain domestic industries need protection. What Kennedy has in mind by way of protection, for instance, is renovation of an old labor-inspired scheme for a federal "trade adjustment program." This would provide for compensation of domestic producers who could prove injury from foreign import competition. Relief would be provided by a combination of subsidies, tax relief, worker retraining and relocation, and other aids.

This does not mean, however, that existing protective measures will soon be scrapped. Actually, peril point, escape clause, anti-dumping, defense essentiality and other means of protection have been strengthened by recent congressional actions.

Kennedy is also expected to intensify the program to spur sales of U. S. products abroad. His plans may involve insuring commercial risks on short-term credits.

On labor issues, of course, the new administration will be more favorably disposed toward union positions. But Kennedy will not back all of labor's demands. For example, he has rejected union proposals for legislating a shorter work-week. Labor will find the Kennedy administration friendly but somewhat standoffish.

The crisis in labor relations resulting from the introduction of automatic controls and automation would be solved, in Kennedy's view, by a national conference of labor and management. Purpose would be to thrash out ideas for alleviating unemployment problems, set up retraining and relocation schemes.

The new President will probably recommend altering the Taft-Hartley Act to increase Presidential authority in national labor emergencies, will support organized labor's demand for repeal of T-H section 14B, which allows states to pass right-to-work laws. He will probably also support a law increasing minimum wages to at least $1.15 an hour.

On general economic policy, Kennedy and his advisers believe business is too sluggish and are working up plans to combat what they consider to be a recession. They plan a number of increased federal spending programs, frankly anticipate a temporary budget deficit that they hope will be eliminated by increased tax revenues resulting from higher levels of output and income.

U. S. INFORMATION AGENCY reports that the rest of the world is buying television sets at a faster clip than ever before; nearly twice as many were sold in the last four months, the agency reports, than in the first six months of the year. The 4 million sets installed during the last four months brings the total of tv sets in use abroad up to 38,650,000, of which 6 million are in the Communist bloc and the rest in non-bloc countries.

Overseas tv transmitting stations increased from 1,237 to 1,353 in the same four-month period. Of these, 248—including 19 of the new installations—are in the Communist bloc. The USIA survey excludes the U. S. and its territories, U. S. Armed Forces stations, and Canada.

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Since 1954, when the Air Force ballistic missile program was accorded top national priority, Space Technology Laboratories has been engaged in virtually every major phase of research, development, testing and technical management of missile and space systems • STL's contributions have hastened the day of operational capability for Air Force ballistic missiles, and have been applied as well in satellite projects and space probes • Today, as STL's activities expand in significance and scope, STL offers exceptional opportunity to the outstanding scientist and engineer whose talents and training will add to, and benefit from, the accumulated experience that has enabled STL to conceive and accomplish major advances in the state-of-the-art • STL's creative flexibility, anticipating and responding to the demands of space progress, ranges in application from abstract analysis to complex hardware fabrication for military and civilian space projects • STL invites scientists and engineers to consider career opportunities in the atmosphere of Space Technology Leadership. Resume and inquiries will receive meticulous attention.

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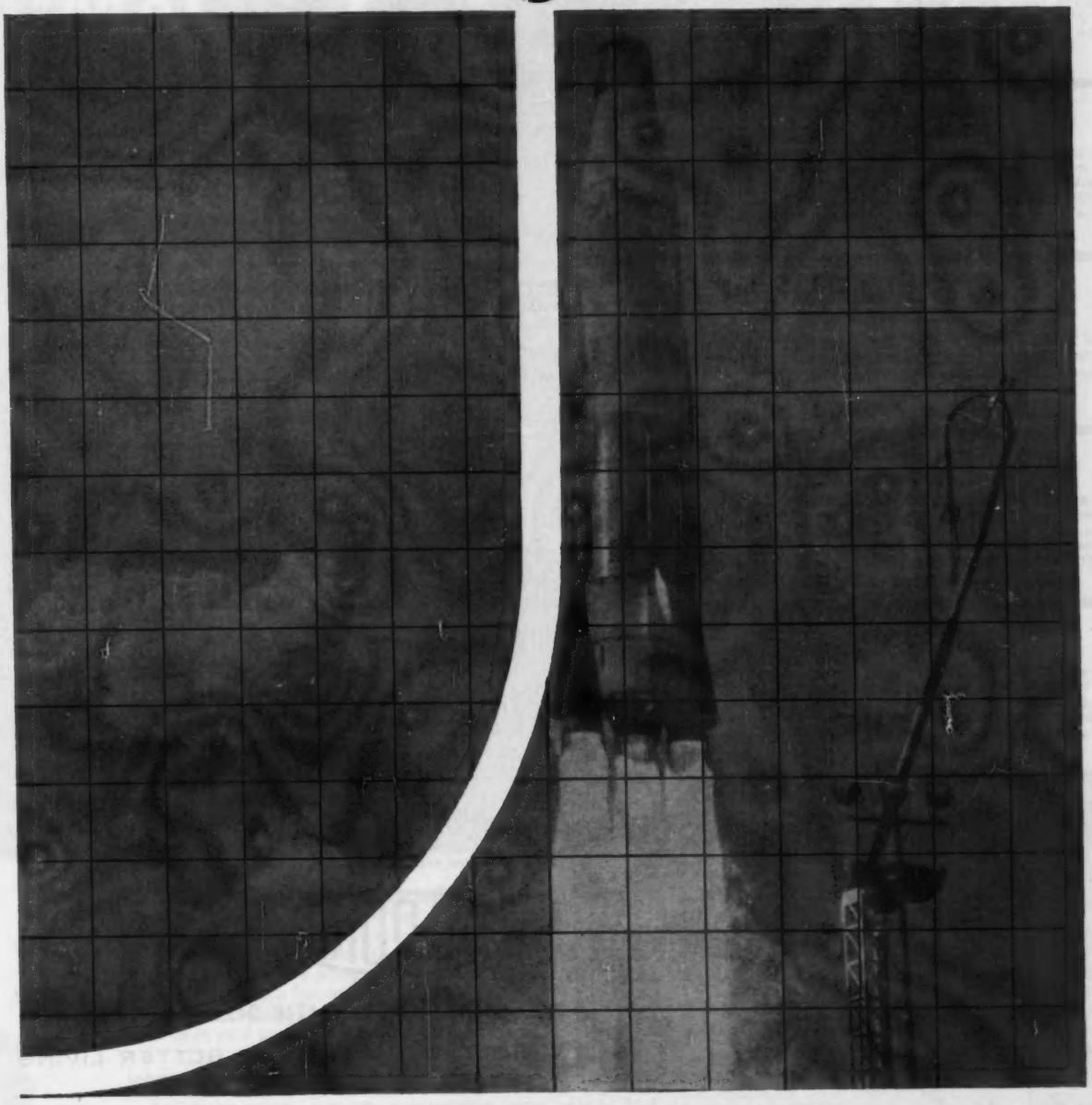
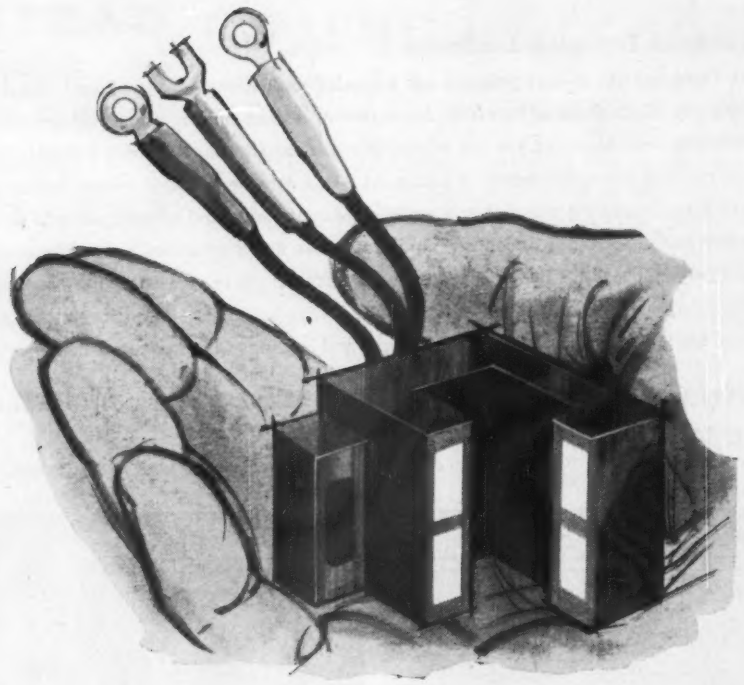




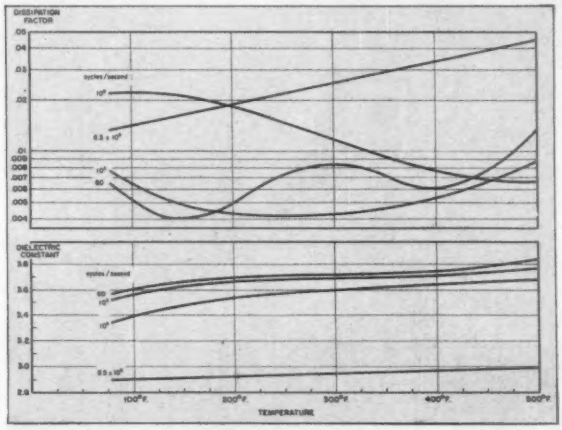
How your epoxy resin potting systems can beat the heat... even above 500° F.

Turn an appraising eye on the chart below, and you will see why it is now possible to get good electrical properties in your epoxy potting compounds even at temperatures of 500° F. and higher.

These data were obtained in tests of epoxy systems which had been cured with Du Pont's pyromellitic dianhydride (PMDA).

Note the unusual stability of electrical properties at elevated temperatures. Equally outstanding thermal resistance is a bonus characteristic of PMDA cured systems.

PMDA is now available in commercial quantities, to help you add these exceptional electrical and thermal characteristics to *your* epoxy resin potting, encapsulating, and laminating systems.



There's more. PMDA provides several advantages in addition to outstanding electrical and thermal properties.

If you wish, you can get long pot life—up to 2 days at room temperature or 6 hours at 165°F. On the other hand, if you want a quick cure—say, 15 minutes at 355° F.—you can get it by simply changing the formulation and at no sacrifice in electricals.

Why not take advantage now of such outstanding performance and use PMDA to achieve improvements in your product. PMDA is now available in quantity from Du Pont's new commercial-size plant. Recent price reduction to $1 per pound* also makes this a practical means of improving your epoxy resin systems.

For more details or for samples of PMDA, write to Du Pont, Explosives Department, 6539-K Nemours Building, Wilmington 98, Delaware.

**Price quoted is f.o.b. Gibbstown, New Jersey for material in standard containers and is subject to change without notice.*

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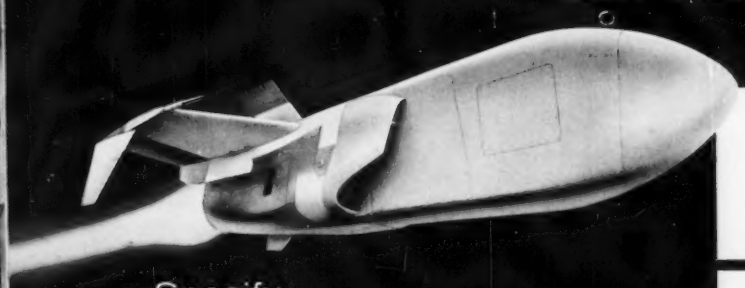

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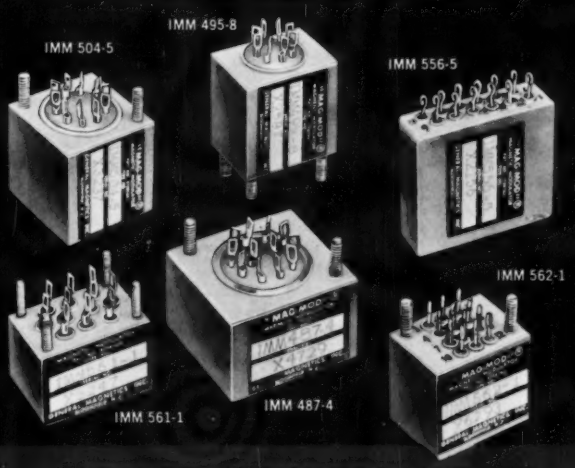
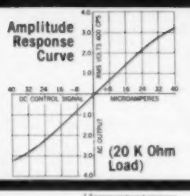
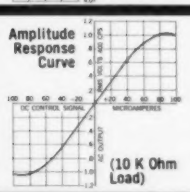




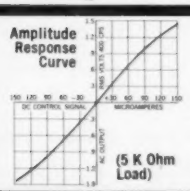
Input Magnetic Modulator
Type No. IMM 487-4

Subminiature "MAG MOD"® featuring high input signal sensitivity and high AC output impedance. Male or female mounting.



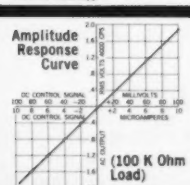
Input Magnetic Modulator
Type No. IMM 495-8

Subminiature "MAG MOD"® featuring wide band width, multiple signal input circuits, extreme zero stability from −65°C to +135°C, low null amplitude or noise level. Mounting available male or female.



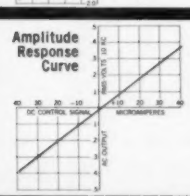
Input Magnetic Modulator
Type No. IMM 504-5

Subminiature "MAG MOD"® featuring low input and output impedance, resistance vs. temperature compensated input, extreme zero stability, repeatability and insignificant hysteresis. Supplied with male or female mounting.



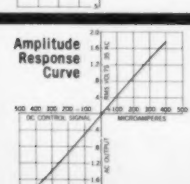
Input Magnetic Modulator
Type No. IMM 562-1

Subminiature "MAG MOD"® featuring 4 KC carrier operation, wide frequency band width, high output impedance and voltage range. Mounting male or female.



Input Magnetic Modulator
Type No. IMM 561-1

Subminiature "MAG MOD"® featuring low carrier energy level operation, very wide frequency band width, wide output operating range, minimum size and weight. Mounting male or female. May be mounted directly on printed circuit boards.



Input Magnetic Modulator
Type No. IMM 556-5

Subminiature "MAG MOD"® featuring high frequency carrier operation (35 KC), flat construction for printed circuit mounting, low output impedance and clean output fundamental frequency wave form. Mounting supplied male or female.

Designed for Subminiature
Circuit Assemblies and Printed Circuit Card Configurations

New miniature designs of these reliable "MAG MODS"® make them ideal for incorporation into transistorized printed circuit assemblies. There is no sacrifice of dynamic response. They offer the engineer/designer the solution to problems involved in a wide range of data systems where analog circuit operations are encountered. To insure complete flexibility, the mechanical mounting on any "MAG MOD" may be modified to conform to your particular packaging requirements.

- **1% repeatability throughout entire service life**
- **Negligible hysteresis**
- **Faster response time**
- **Extreme stability over a wide temperature range**
- **Infinite service life**
- **Extremely lightweight—compact design**

GENERAL MAGNETICS • INC
135 BLOOMFIELD AVENUE, BLOOMFIELD, NEW JERSEY, U. S. A.

GM INC.

See reverse side for specifications

Specifications for General Magnetics' Sub-Ounce Line of

"MAG MOD"® *miniaturized* MAGNETIC MODULATORS

TYPE NUMBER	IMM 487-4	IMM 495-8	IMM 504-5	IMM 562-1	IMM 561-1	IMM 556-5
Excitation Carrier Voltage and Frequency	115 V @ 400 cps	115 V @ 400 cps	115 V @ 400 cps	2.5 V RMS @ 4 KC	1.0 V RMS @ 10 KC	6 to 10 V RMS @ 35 KC
Control Signal Winding DC Resistance	Winding No. 1 6200 ohms Winding No. 2 7400 ohms	Signal Winding No. 1 550 ohms Signal Winding No. 2 600 ohms	1000 ohms	Signal Winding 1300 ohms Feedback Winding 160 ohms	200 ohms	5000 ohms
Input Control Signal Range	0 to ±40 μa Each Winding	0 to ±100 μa (Both Sig. Windings in Series)	0 to ±100 μa	0 to ± 100 μa 0 to ± 1 V Bipolar	0 to ±400 μa	0 to ±400 μa
Amplitude Modulated AC Output Range	3 V RMS @ 400 cps Phase Reversing	0 to 1 V RMS @ 400 cps Phase Reversing	0 to 1.5 V RMS @ 400 cups Phase Reversing	0 to 6 V RMS @ 4000 cps Phase Reversing	0 to 3 V RMS @ 4 KC Phase Reversing	0 to 1.8 V RMS @ 35 KC Phase Reversing
Differential Gain RMS mv AC Out/μa Signal In	100 mv/μa	15 mv/μa	10 mv/μa	200 mv/μa	10 mv/μa	4.2 mv/μa
Null Amplitude (Noise Level) mv RMS	25 mv RMS Maximum	5 mv RMS Maximum	10 mv RMS Maximum	30 mv RMS Maximum	10 mv RMS Maximum	20 mv RMS Maximum
Output Impedance	Approx. 30 K ohms	1600 ohms	1000 ohms	Approx. 70 K ohms	Approx. 40 K ohms	900 ohms Each Output Wind.
External Load (Suggested)	Approx. 20 K ohms	Approx. 10 K ohms	Approx. 5 K ohms	Approx. 100 K ohms	Approx. 100 K ohms	1000 ohms Each Output Wind.
Null Drift (In terms of Input Signal) —65°C to +135°C	Less than ±0.25 μa Over Temp. Range	Less than ±0.25 μa Over Temp. Range	±1 μa Maximum Over Temp. Range	±0.5 μa Maximum Over Temp. Range	±1 μa Over Temp. Range	±2 μa Over Temp. Range
Hysteresis (% of Input Control Signal)	0.5% Maximum	0.5% Maximum	0.5% Maximum	Approx. 0.5%	0.5% Maximum	0.5% Maximum
% Harmonic Distortion in Output AC Modulated Envelope	Approx. 40% (3rd Harmonic)	Approx. 25% (3rd Harmonic)	Approx. 30% (3rd Harmonic)	Approx. 15% (3rd Harmonic)	Less Than 10% (3rd Harmonic)	Approx. 5% (3rd Harmonic)
Overall Dimensions (In Inches)	1¼ x 1⅛ x ⅜	⅜ x 1 x 1	1 x 1 x 1	1 x 11/16 x ⅞	11/16 x 1 x ⅜	7/16 x 1⅜ x 1¼
Type of Mounting	4-40 Studs or Inserts	4-40 Studs or Inserts	4-40 Studs or Inserts	4-40 Studs or Inserts	2-56 Studs	4-40 Tapped Holes or Studs
Weight in Ounces	Approx. 1.25	Approx. 1	Approx. 1.1	0.75	0.6	1
Response Time (Band Width cps)	0.01 sec. for 15 K Sig. Source Imp. (12 cps Corner Frequency)	20 cps for 10 K Sig. Source Imp. 25 cps for 20 K Sig. Source Imp. (Both Sig. Windings in Series)	5 cps for 1 K Sig. Source Imp. 10 cps for 5 K Sig. Source Imp. 20 cps for 10 K Sig. Source Imp.	70 cps for 10 K Sig. Source Imp. (Time Constant Approx. 2 Milli-Seconds)	Corner Frequency 2 KC for Sig. Source Imp. of Approx. 6 K ohms	Corner Frequency 200 cps for 600 ohm Signal Source Imp. or 1000 cps for 5 K Source

Magnetic Multiplying Modulator Model MCM 515-1

The MAGNETIC MULTIPLIER is a miniaturized magnetic modulator specifically designed to deliver an analog output voltage which is the continuous product of two variable input voltages. One of these is an excitation voltage which varies over a pre-determined range; in this case, 0 to 1 VRMS 400 cycles per second. The other signal is a DC current which varies between 0 and ±400 μa. The output voltage is 400 cycles AC, and is always in phase or 180° out of phase with the variable excitation or fixed reference, i.e., in phase when the variable amplitude DC signal is positive, and 180° out of phase when the DC signal is negative. The general schematic is illustrated in Fig. 1. The relationship between variable alternating supply signal voltage E_B, variable direct current control signal E_C, and the alternating load voltage E_L, having a sinusoidal wave shape is denoted by the equation—

$$E_L = \text{Constant} \times E_B \times E_C.$$

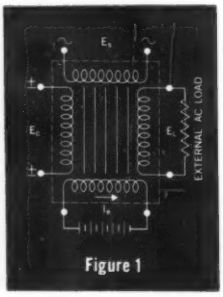


Figure 1

This expression, which defines the fundamental principle of the four quadrant MAGNETIC MULTIPLYING MODULATOR, can be clearly illustrated by linear transfer response curve families as shown at right, in Figure 2-A and Figure 2-B.

Illustrating:

(1) **Load voltage E_L as a function of alternating supply signal voltage E_B with control DC signal voltage E_C as a parameter.**

(2) **Load voltage E_L as a function of control DC signal voltage E_C with alternating supply voltage, E_B as a parameter.**

With linearity response curves held to within approximately 1 to 2% of theoretical straight lines, the product accuracy of the fundamental equation will be within 2 to 5% of the theoretical product.

SPECIFICATIONS MODEL MCM 515-1	
Variable Excitation Carrier Voltage and Frequency	Variable AC Signal 0 to 1 V RMS 400 cps
Control Signal Winding DC Resistance	DC Signal Winding Resistance 2650 ohms
Input Control Signal Range	Variable DC Signal 0 to ±400 μa
Amplitude Modulated AC Output Range	0 to 0.9 V RMS @ 400 cps Phase Reversing
Null Amplitude (Noise Level) mv RMS at Max. AC Excitation	5 mv RMS
Output Impedance	Approx. 3500 ohms
External Load (Suggested)	Approx. 25 K ohms
Null Drift (In terms of Input Signal) —65°C to +135°C	±2 μa over Temperature Range
Hysteresis (% of Input Control Signal)	0.5% Maximum
% Harmonic Distortion in Output AC Modulated Envelope	Less than 5%
Overall Dimensions (In Inches)	27/32 x 27/32 x 1 3/16
Type of Mounting	4-40 Insert or Stud
Weight	Approx. 1 Ounce

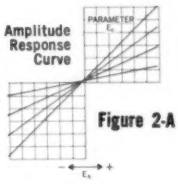


Figure 2-A

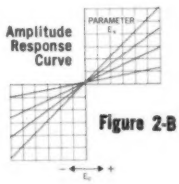


Figure 2-B

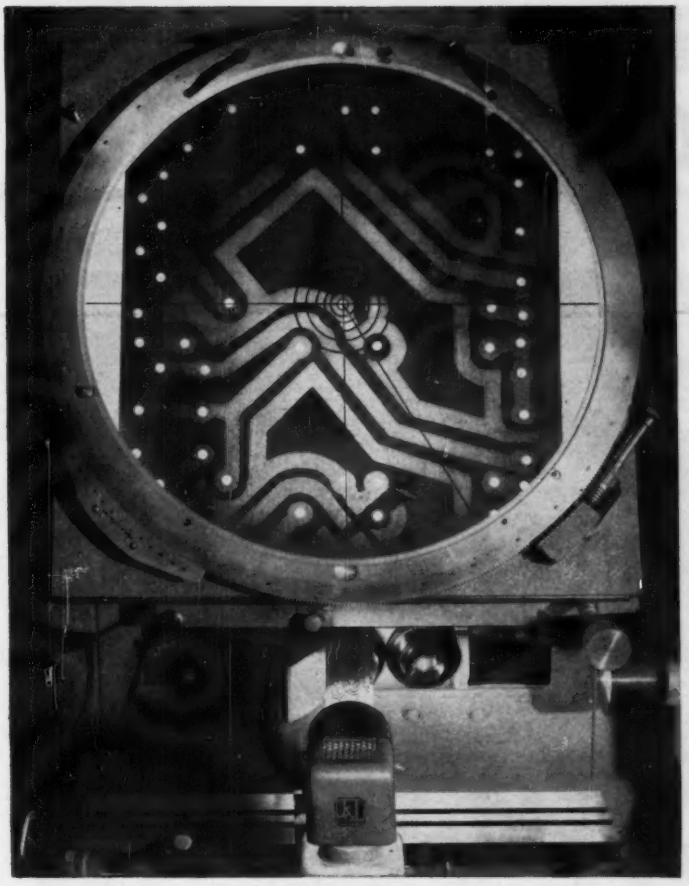
Typical "Mag Mod"® Applications—Circuit applications for MAGNETIC MODULATORS include algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gain, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.

Consult General Magnetics—For magnetic amplifier components of proven reliability. These dependable instruments are widely employed in automatic flight systems, fire control, analog computers, guided missiles, nuclear equipment, antennas, gun turrets, commercial power amplifiers and complete control systems. Miniature, subminiature, standard and customized types available.

Call or write for new Brochure 102 on "MAG MOD" Miniaturized Magnetic Modulators and Magnetic Multiplying Modulators. Please address inquiries on company letterhead.

GENERAL MAGNETICS • INC

135 BLOOMFIELD AVENUE, BLOOMFIELD, NEW JERSEY, U. S. A.



J & L Comparators are ideally suited for inspection of printed circuits — because they provide coordinate measuring facilities corresponding to the method by which circuits are dimensioned.

In mating the printed circuit with other components, it is necessary that the terminal points be located accurately. Also — to assure a uniform flow of current through the connectors, the drilled holes at the terminals must be centralized within the circuitry.

A Comparator, equipped with a surface illuminator, projects a reflected image to a chart having radii and lines. By comparing the image of the drilled holes to the radii on the chart the size and location of the holes may be determined.

True precision like this never comes cheap!

Of all the possible areas in which to economize, quality inspection is the least promising. Why?

Simply because the kind of intensive research, painstaking engineering and top-quality manufacture it takes to produce precision inspection equipment like the J&L Comparator just CAN'T be offered at bargain-basement prices. On the other hand, cheap equipment doesn't belong in the same league with a J&L Comparator when it comes to accuracy, speed, versatility and all-round dependability. When it comes to true precision of inspection, a cheap comparator can prove to be *terribly* expensive.

J&L Comparators come in 11 models, both bench and pedestal type.

"The originator of machine tool standards in optical inspection"

JONES & LAMSON

JONES & LAMSON MACHINE COMPANY, Dept. 710, 539 Clinton Street, Springfield, Vt., U.S.A.
Please send me Comparator Catalog 5700, which describes the complete line of J&L Optical Comparators.

name _____ title _____

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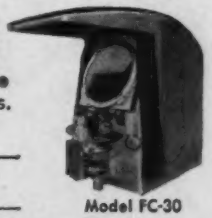
city _____ zone _____ state _____



Model FC-30

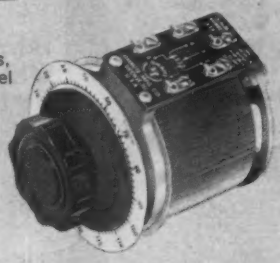
The OHMITE "VT" Series Has

EVERYTHING YOU WANT IN

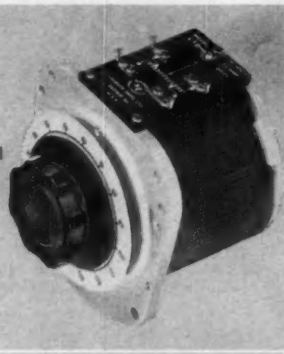
OPEN UNITS

1.5 to 1.8 amps, basic Model VT2

3.5 to 4.75 amps, basic Model VT4



7.5 to 10 amps, basic Model VT8



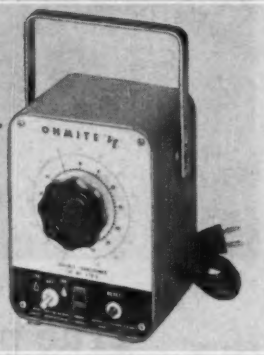
ENCLOSED UNITS

Fixed, VT2, VT4, VT8

Portable, VT2

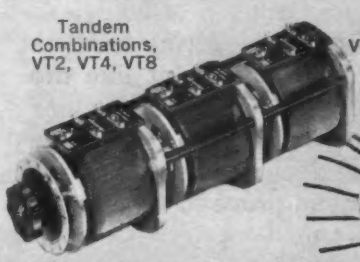
Portable, VT4, VT8

Deluxe Portable, VT8



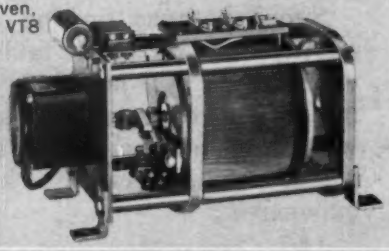
SPECIAL FEATURES

Tandem Combinations, VT2, VT4, VT8



Multi-Tap, VT2, VT4, VT8

Motor Driven, VT2, VT4, VT8



IMMEDIATE DELIVERY

From Distributor and Factory Stocks

Thirty-eight different types, including individual transformers, two-in-tandem, three-in-tandem, cased, low-voltage, single-phase, three-phase, fixed mounting, portable and accessories.

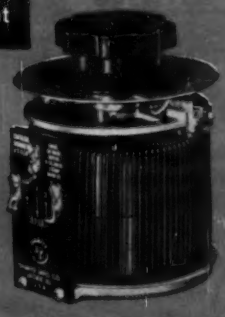
VARIABLE TRANSFORMERS

FROM 1.5 TO 10 AMPS

LOW VOLTAGE High Current

36 volts, 5 amps, basic Model VT2LN

36 volts, 12 amps, basic Model VT4LN



36 volts, 22 amps, basic Model VT8LN

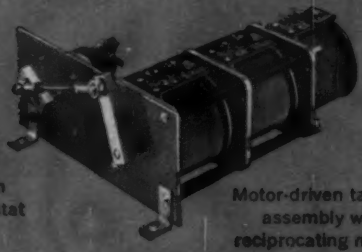
UL APPROVED

At the present time, Model VT8 carries the UL label.
Model VT4 is undergoing final tests, and VT2 will be submitted soon.

CUSTOM ENGINEERED

Double Track Transformer

With Rheostat



Motor-driven tandem assembly with reciprocating motion

Whether your special needs are mechanical or electrical, simple or complex, Ohmite can engineer and manufacture the job in any quantity you desire. Units shown above are typical examples.

OHMITE *"V.t."*

VARIABLE TRANSFORMERS

Write for Bulletin 151D

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois

Rheostats • Power Resistors • Precision Resistors
Variable Transformers • Tantalum Capacitors • Tap Switches
Relays • R.F. Chokes • Germanium Diodes • Micromodules

OHMITE

RUSHING TO A RADAR'S RESCUE

Lockheed Electronics engineers – anywhere –service every make of electronic equipment

A ship's "eyesight" needs immediate attention—a Lockheed Electronics service engineer swings aboard on a breeches buoy to make on-the-spot adjustments that keep critical electronic systems at peak performance.

Another LEC service engineer may be installing telemetry equipment at a missile base; while still another, ten miles up in the stratosphere, evaluates a jet bomber's ECM system.

These LEC experts are qualified to install, test, modify right in the field, evaluate and maintain *any* equipment—made by *any* manufacturer.

Lockheed Electronics' highly trained specialists represent a new concept in service engineering. An unusually large proportion hold advanced degrees, and LEC's Engineering Services Division keeps them all constantly abreast of the latest advances in the state of the electronics art.

If you want men with the right skills and full knowledge of your electronic problem, call on Lockheed Electronics, Engineering Services Division.

CAPABILITIES—ENGINEERING SERVICES DIVISION

Maintenance engineering
Range instrumentation and operation
Equipment modification • Installation engineering
Training programs, manuals and materials
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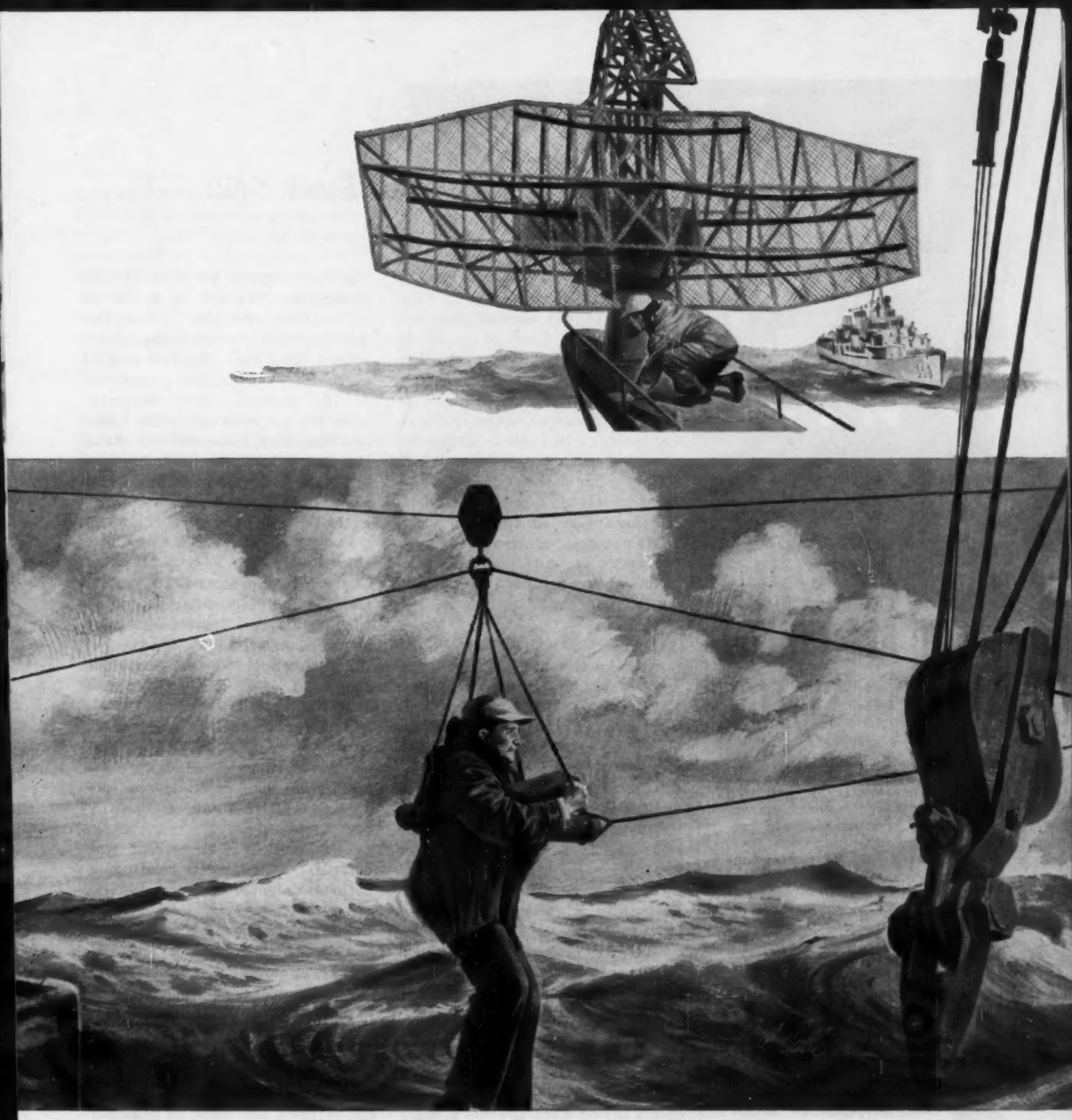

MINDING THE FUTURE

LOCKHEED ELECTRONICS COMPANY

ENGINEERING SERVICES DIVISION, METUCHEN, N. J.

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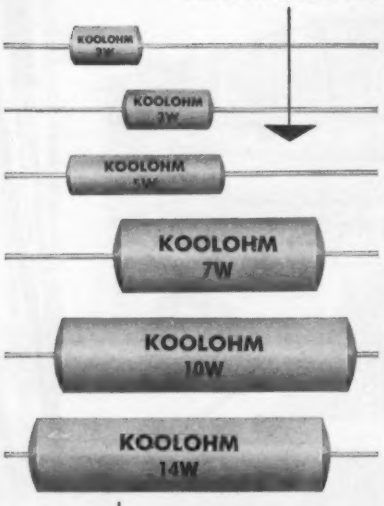
CIRCLE 23 ON READER SERVICE CARD

ALL UNITS ACTUAL SIZE



KOOLOHM®
INSULATED SHELL
POWER RESISTORS

Sprague's Koolohm Resistors are designed to meet military and industrial requirements for insulated power wirewound resistors that will perform *dependably*.

New axial-lead Koolohm construction features include welded leads and winding terminations. Exclusive Ceron® ceramic-insulated resistance wire, wound on special ceramic core makes possible multilayer non-inductive windings and extra-high-resistance-value conventional windings. Dense, non-porous ceramic outer shells provide both humidity and mechanical protection for resistance elements. All resistors are *aged-on-load* to stabilize resistance value.

The advanced construction of these improved Koolohm Resistors allows them to operate at "hottest spot" temperatures up to 350°C. *You can depend upon them to carry maximum rated load for any given physical size.*

Send for Engineering Bulletin 7300A for complete technical data.

SPRAGUE ELECTRIC COMPANY
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SPRAGUE®
THE MARK OF RELIABILITY

Martin Plans Stock Split

MARTIN COMPANY directors have approved a two-for-one stock split and increase of the regular quarterly cash dividend from 40 cents per share to 50 cents, an annual dividend of $2.00 instead of $1.60. The payments will be made on Dec. 21. Also recommended by company directors is an increase in authorized shares of capital stock from six million at a par value of $1, to 12 million shares. A special stockholder meeting is slated for Jan. 9. If shareholders approve the increase, the company will issue one additional share for each share now outstanding.

Avien Inc., Woodside, N. Y., reports annual sales for fiscal 1960 were $5,041,000, a drop from the $7,749,000 of 1959. Net earnings were also lower, standing at $189,000 this year as compared with last year's $301,000. Per share earnings for fiscal 1960 were 31 cents as against the 1959 figure of 50 cents. Company officials say their gross sales forecast for fiscal 1961 is over $10 million.

Electronic Engineering Co. of California, Santa Ana, announces consolidated net income of $192,000 for the third quarter of 1960, which ended in September. Company officials say this is the highest quarter in company history. After taking losses sustained during the first quarter of this year into account, cumulative earnings for the nine-month period were 42 cents a share on 357,462 shares outstanding. Sales for the third quarter were $1,629,000, as compared with $1,324,000 in the same period of 1959. This is an increase of 23 percent. Net income was up 76 percent with $193,000 reported for the period. For the same segment of 1959 net was $109,000.

Total assets for **Texas Instruments Incorporated** after depreciation are expected to be about $120 million by the end of this year, according to company president P. E. Haggerty. This will be a rise of $27 million over the 1959 figure. Also expected is a rise in the rate of return. Last year, this rate was 10 percent. This year, it is expected to be 13.7 percent. Other estimates are that net earnings after taxes and preferred dividends will stand between $15,250,000 and $15,750,000, or approximately $3.90 to $4.00 a share. Net earnings after taxes in 1959 were $14,143,000 or $3.59 a share.

Century Geophysical Corp., Tulsa, Okla., and its subsidiary, **Century Electronics and Instruments**, announce quarterly sales for the period ended Sept. 30, this year were $1,833,851, of which the electronics subsidiary contributed $834,656. Income for the quarter before taxes amounted to $123,661. About 59 percent of quarterly sales were derived from commercial sources, according to T. A. Manhart, company president.

The remaining 41 percent was derived from contracts relating to national defense.

Telautograph Corp., Los Angeles, has filed with Securities and Exchange Commission seeking registration of shares of common stock for subscription by present shareholders. The number of shares and subscription terms will be announced later. Baird & Co., Richard J. Buck & Co. and Chace, Whiteside and Winslow are listed as principal underwriters. Funds from the stock sale will be used for expenses relative to development of new facsimile gear compatible with common carrier analog subset equipment. A portion of the proceeds will be used for debt retirement.

Bowmar Instrument Corp., Ft. Wayne, Ind., reports record sales and earnings—up more than 60 percent over last fiscal year. Sales this year were $5,411,822, as against last year's $3,344,482. Earnings

were $323,664, up 61 percent from 1959's $201,220. Per share earnings for this fiscal 12-month period were 85 cents based on 379,560, as compared with 63 cents in fiscal 1959 based on $319,800 shares outstanding. E. A. White, company president, says a two-for-one stock split will be voted at the annual stockholders meeting slated for next Tuesday.

Arco Electronics, New York, which became listed on the American Stock exchange last month, reports sales of $2,530,221 for the fiscal year ended Sept. 30. Net income for the period was $280,304, or 33 cents per share on 845,000 shares outstanding. The company, which recently became publicly owned, changed the date of its fiscal year in 1959. Because of this, sales and earnings figures for the previous year were calculated on a projection of the first nine months of 1959. These indicated a total proforma profit for the year ended Sept. 30, 1959 of $168,121, or 21 cents a share on sales of $1,999,309. Sales for this current fiscal year amounted to $2,530,221.

25 MOST ACTIVE STOCKS

WEEK ENDING NOVEMBER 25, 1960

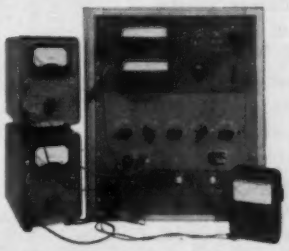
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Ampex	2,286	26⅛	22⅞	23¼
Univ Controls	1,032	16	14⅝	15¼
Transitron	936	35¼	33⅜	35¼
Standard Kollsman	762	24⅞	22⅝	24
Martin	715	61½	57¾	61⅛
Gen Tel & Elec	659	26⅝	26⅛	26¼
Int'l Tel & Tel	587	42⅞	40⅛	42⅞
RCA	545	57⅜	53⅝	57⅛
Gen Electric	537	78¾	75½	77⅜
Sperry Rand	537	19⅛	18⅝	18⅞
Litton Ind	501	89	83¼	89
Motor	490	8¼	6¾	7½
Gen Dynamics	477	42	38⅝	42
Lockheed	394	27⅝	26⅜	27⅜
Varian Assoc	379	48¾	44¾	47⅞
Gen Instr	353	39⅜	37½	39¼
Barnes Eng	332	40½	34⅜	39⅜
Avco Corp	325	13⅞	13¼	13⅜
Collins Radio	310	51¾	47⅝	51½
Westinghouse	307	50	48¾	49¾
Philco	304	18¼	17½	17½
Elec & Mus Ind	276	6¼	6	6⅛
Burroughs	245	28⅜	27½	28
Reeves Sndcrft	239	6⅝	6⅛	6⅜
Raytheon	238	34	32½	34

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

7 benefits for you with trio labs' BUILD-IN concept

By designing-in trio miniature panel-mounting instruments into operating and testing equipment, you:

- customize both your test set-up and instruments
- save space (average trio model is 4" x 4" x 4")
- save time: at-a-glance sequential or continuous monitoring
- save money: exclude unnecessary instrument functions, ranges
- make monitoring foolproof: read "go no-go" by switching
- improve testing efficiency and system reliability
- increase overall design freedom



BEFORE . . . 3 external instruments were used to measure AC and DC voltages . . . cluttered, tedious, wasteful, subject to error.

AFTER . . . 3 trio VTVMs integrally built-in now are always on hand to measure just the parameters you designate.

3 ways you can use Trio Labs' pioneer know-how . . .

1. choose from trio's complete line of "standard" models.
2. select a "special" already produced—and you save the engineering time and money that went into it.
3. consult us for design specific to your own needs.

trio®

Write for free "how to" Engineering Guide to Dept. E-12

TRIO LABORATORIES, INC., PLAINVIEW, L. I., NEW YORK

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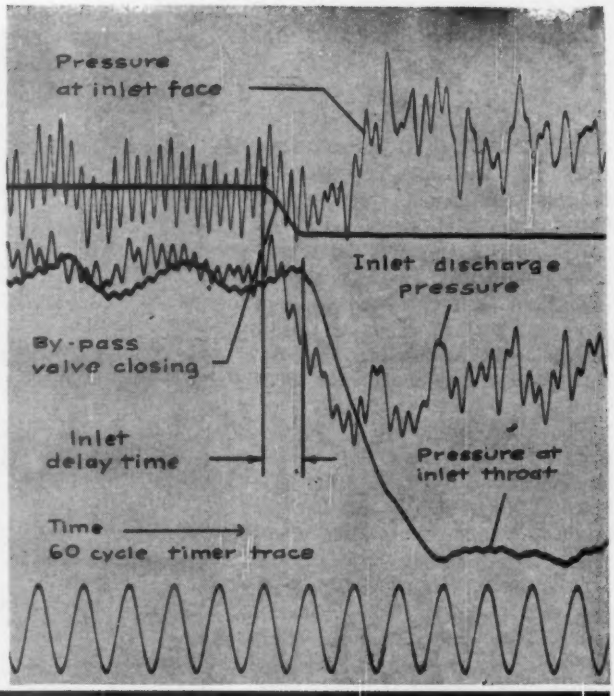
In research...

A Model 906 Honeywell Visicorder wrote this record of pressure fluctuations... "buzz"... for engineers at the NASA Lewis Flight-Propulsion Laboratory in Cleveland. "Buzz" is an unsteady variation in the pressure and airflow characteristics of a supersonic aircraft or missile inlet. These Visicorder studies defined the buzz-free operating limits of the inlet, and provided the designers with structural load information in case the inlet were inadvertently caused to operate on buzz during flight. This load information is vital, for inlet buzz can result in fluctuating structural loads of the order of 1000 psf... loads which could cause structural failure of the inlet and loss of the airplane. Visicorder records such as this have played an important role in the design of inlet control systems.

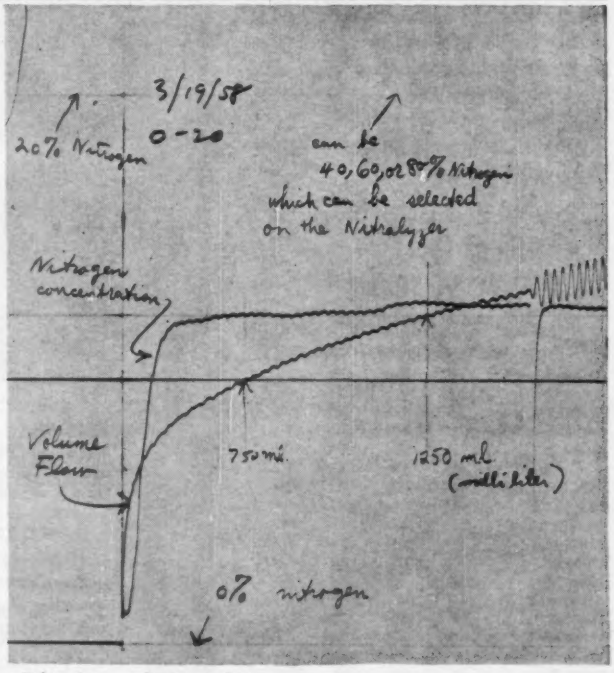


these are records of leadership

In medicine...

This directly-recorded Visicorder chart has told the scientists of the U. S. Public Health Service Occupational Health Program an important story about uneven alveolar ventilation in the human lung during a single breath of oxygen. In these lung function tests, the Visicorder measured anatomic dead space and abnormalities in the distribution of inspired gas in the alveoli of the lungs. The subject, under test, inhaled 100% oxygen to dilute nitrogen in the lungs. The Visicorder recorded the volume and the nitrogen percent of the exhalation. In these and in hundreds of other scientific and industrial applications, Visicorders are bringing about new advances in product design, computing, control, rocketry, nucleonics and production.

For information on applying the unlimited usefulness of the Visicorder to your specific problems, phone your nearest Honeywell Industrial Sales Office.



Visicorder records 2/3 actual size.

The Honeywell Visicorder provides instantly-readable, high-sensitivity data at frequencies from DC to 5000 CPS. There are models with 8, 14, or 36-channel capacities.

Honeywell

Industrial Products Group

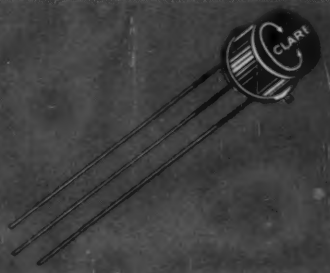
Reference Data: Write for specifications on Visicorders 906B, 1108 and 1012.

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado

these three categories of

CLARE GERMANIUM ALLOY TRANSISTORS

solve major design and procurement problems



HIGH VOLTAGE • 2N398, CP398, 2N1310, CP98
Characteristics @ 25° C

Parameter		2N398 PNP	CP398 PNP	2N1310 NPN	CP98 PNP
BV_{CBO}	(Min.)	−105 Vdc	−105 Vdc	+90 Vdc	−65 Vdc
V_{RT}	(Min.)	−105 Vdc	−105 Vdc	+90 Vdc	−65 Vdc
$f_{\alpha b}$	(Min.)	—	—	—	4 mc
	(Typ.)	—	1 mc	1 mc	—
h_{FE}	(Min.)	20 at I_C=−5 mAdc	30 at I_C=−5 mAdc	20 at I_C=+5 mAdc	30 at I_C=−30 mAdc
Max. Rated Dissipation		50 mW	120 mW	120 mW	150 mW

DRIFT • 2N602, 2N603, 2N604
Characteristics @ 25° C

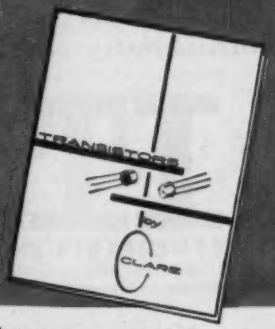
Parameter		2N602	2N603	2N604
f_T	(Min.)	10 mc	30 mc	50 mc
	(Typ.)	20 mc	40 mc	60 mc
BV_{CBO} I_C=−25μAdc	(Min.)	−20 Vdc	−30 Vdc	−30 Vdc
BV_{EBO} I_E=−50μAdc	(Min.)	−1 Vdc	−1 Vdc	−2 Vdc
h_{FE}	(Min.)	20	30	40
I_B=−0.5 mAdc	(Max.)	80	100	140
V_{RT}	(Min.)	−20 Vdc	−20 Vdc	−30 Vdc

MEDIUM POWER • 2N597, 2N598, 2N599
Characteristics @ 25° C

Parameter		2N597	2N598	2N599
$f_{\alpha b}$	(Min.)	3 mc	6.5 mc	12 mc
	(Typ.)	8 mc	10 mc	18 mc
Max. Rated Dissipation		250 mW	250 mW	250 mW
h_{FE} I_C=−100 mAdc	(Min.)	40	70	100
BV_{CBO} I_C=−25μAdc	(Min.)	−45 Vdc	−35 Vdc	−30 Vdc
I_{CBO} V_{CB}=−15 Vdc	(Max.)	−8μAdc	−8μAdc	−8μAdc

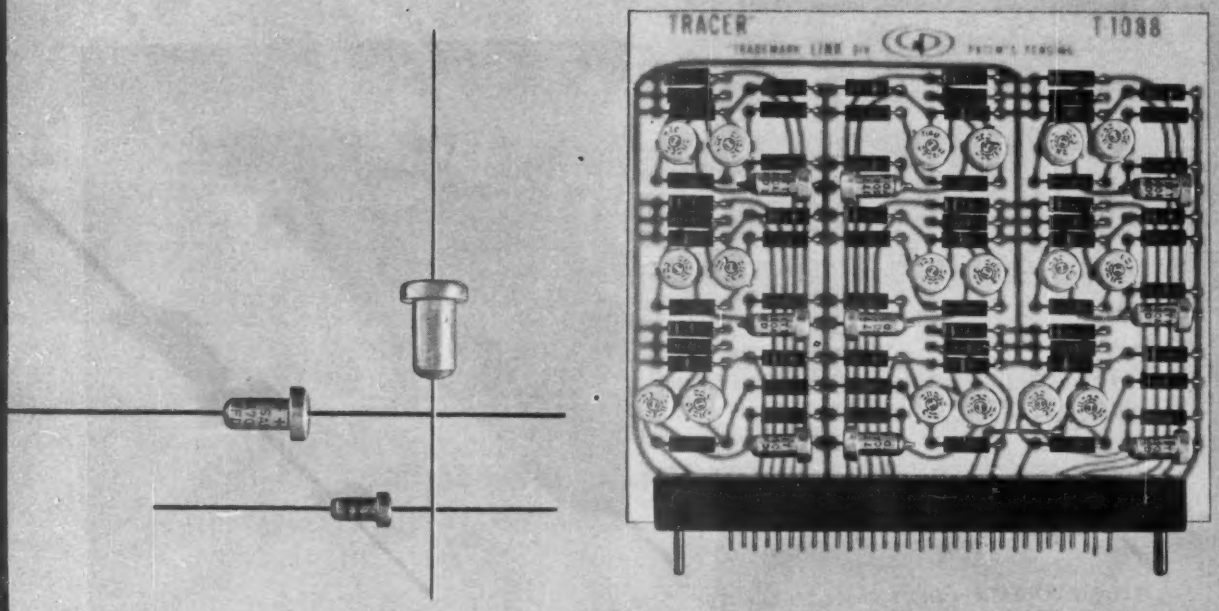
91 types of Clare Transistors offer you a wide variety of devices with just one standard of quality—the very highest. The three categories mentioned above demonstrate Clare ability to produce hard-to-make transistors in a manner which makes them easy-to-buy. The broad Clare Transistor line comprises the range you need for complementary logic, high frequency logic, neon bulb drivers, core and solenoid drivers, and high current switches.

Top-quality standard units, with special devices for special needs, make Clare an important source for you. Contact your nearest C. P. Clare & Co. sales office...or C. P. CLARE TRANSISTOR CORPORATION, 260 GLEN HEAD ROAD, GLEN HEAD, L. I., NEW YORK.



For specifications on 91 typical Clare Transistors, circle Reader Service Card Number **262**

C.P. CLARE TRANSISTOR CORPORATION • GLEN HEAD, NEW YORK



Link Division of General Precision, Inc. specified ITT capacitors for this vital portion of its Tracer Identification and Control System, which demands utmost reliability and long life expectancy from every component.

TOTAL PROCESS CONTROL AND DISCIPLINED PRODUCTION DELIVER

HIGH-RELIABILITY WET-ANODE TANTALUM CAPACITORS FROM ITT

ITT wet-anode tantalum capacitors meet MIL-C-3965B—a fact proved by independent laboratory qualifications tests on ITT capacitors. The reliability and long life expectancy of these competitively-priced capacitors are direct results of ITT's total process control and disciplined production procedures, above and beyond testing standards more stringent than normal industry practice—and backed by ITT's world-wide facilities and experience.

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INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
815 SAN ANTONIO RD., PALO ALTO, CALIF.

Phone these ITT-CD Capacitor Sales Offices:

Albuquerque	AX 9-8013	Los Angeles	HI 6-6325
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Chicago	SP 7-2250	Minneapolis	WE 9-0457
Cleveland	GR 5-3080	New York	LO 5-1820
Dallas	EM 1-1765	Philadelphia	TR 8-3737
Dayton	BA 8-5493	Phoenix	WH 5-2471
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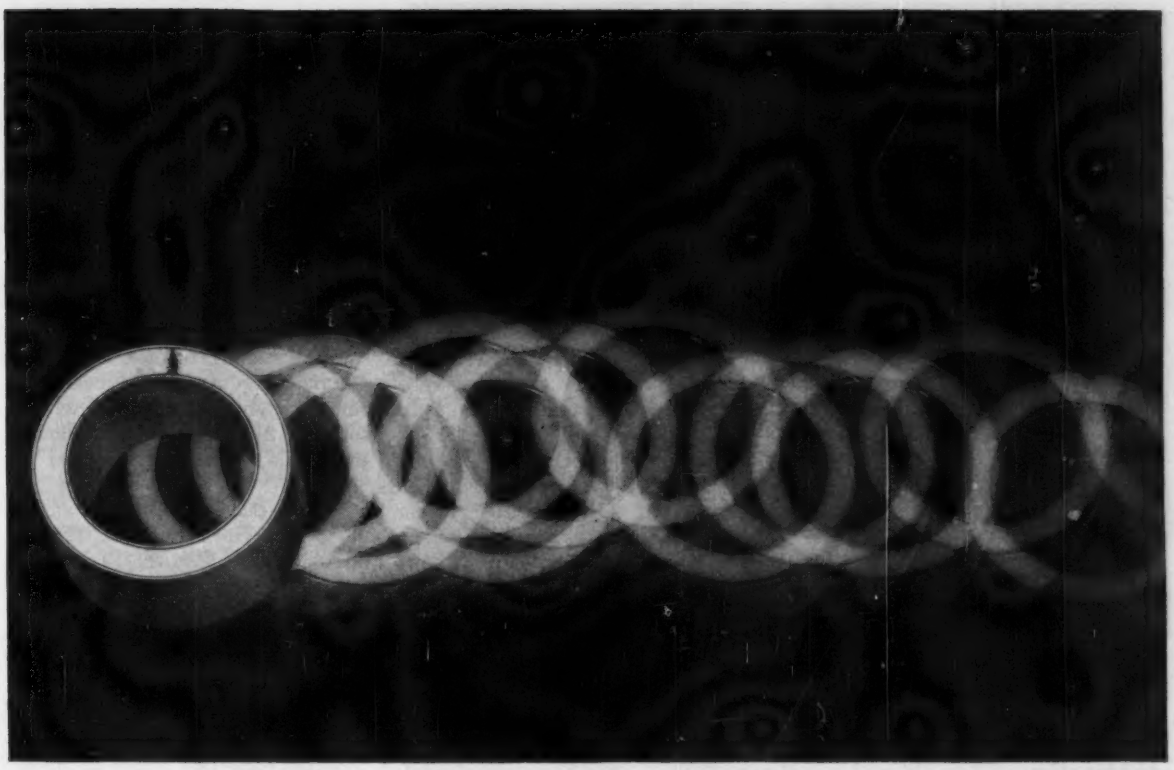
IN STOCK AT ITT DISTRIBUTORS:

- TWO TYPES—M-Type and P-Type, for applications from −55 to 85 and 125 C. respectively
- 29 VALUES—from 1.75 to 330 mfds over a working voltage range to 125 VDC and maximum surge voltages to 140 VDC
- COMPACT AND RUGGED—sintered tantalum slug in fine-silver cases for 2000-hour life at maximum temperature and working voltage
- GUARANTEED—to 80,000 ft. and accelerations of 20 G's with a 0.1 in. excursion in 50-2000 cps range
- LONG STORAGE LIFE—tantalum-oxide dielectric is completely stable; assures trouble-free operation

COMPLETE SPECIFICATIONS ON ITT wet- and solid-anode tantalum capacitors are available on request. Write on your letterhead, please, to the address below.

ENGINEERS: Your ITT representative has a complete set of qualifications and quality control tests for your inspection.



the strong case for Centricores®

When you're considering magnetic cores it pays to get down to cases. The sturdy aluminum case for Centricores assumes special importance where impact, vibration, heat or mechanical pressure could cause trouble in a control loop you're designing, or where you want to miniaturize an inductive component.

The case is ruggedly rigid, so that you can apply your circuit windings without danger of distorting the core's magnetic properties. And the case is absolutely leakproof. You can vacuum-impregnate Centricores without danger of their damping oil leaking out or foreign matter leaking in. The tightly sealed case also guards against leakage in applications where high ambient temperatures are present, or where Centricores are used in rotating equipment.

Here's a tip on miniaturization. The rugged design of the Centricore case permits use of a thinner gage aluminum that shaves fractions of an inch off their size—fractions that can add up to precious inches where you want to scale down component dimensions. *Centricores are the slimmest magnetic cores on the market.*

Centricores are the most uniform. They give the exact performance you want, from core to core and lot to lot. Their remarkable consistency in insulation, dimensions, squareness, thermal stability and gain is the product of unique quality controls that begin with the very selection of raw materials and extend through final testing.

Write for complete data. Centricores are available from stock from our East and West Coast plants in all standard sizes and magnetic qualities, and in both aluminum and phenolic cases. We will match them within 5 per cent over the entire voltage-current loop, in sets, units or in multiples up to twelve. Write for detailed specifications today.

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transformer laminations • motor laminations • tape-wound cores
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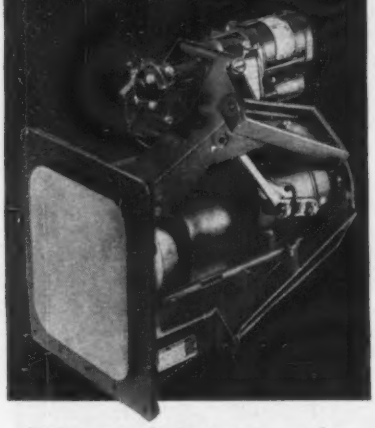
←CIRCLE 28 ON READER SERVICE CARD

CIRCLE 29 ON READER SERVICE CARD 29

Another
electromechanical
problem solved by
AiResearch



This ram air scoop is another example of AiResearch's ability to design and integrate structural and electromechanical systems for control functions.

Through its use, air is provided for emergency cabin pressurization and the cooling of electronic components. The unit is composed of a retractable aluminum ram air scoop, extended and withdrawn by a 400 cycle rotary actuator, a self-contained 350 watt heating element and an integral check valve.

The most experienced company in the development and production of control systems for airborne and ground use, AiResearch has the ideal facilities and know-how to handle problems concerning electromechanical systems and components of all types for aircraft, ground handling, ground support and missile systems.

OTHER ELECTROMECHANICAL COMPONENTS AND SYSTEMS

AC and DC Motors, Generators and Controls • Static Inverters and Converters • Linear and Rotary Actuators • Power Servos • Hoists • Temperature and Positioning Controls • Sensors • Programmers • Missile Launchers • Radar Positioners • Power Supplies • Williamsgrip Connectors

Your inquiries are invited.

THE GARRETT CORPORATION
AiResearch Manufacturing Division
Los Angeles 45, California

Canada Consumer Sales Dip

CANADA'S present population of some 17½ million is now being served domestically by almost 200 electronics companies according to information from the electronics branch of the Dominion's Department of Defense Production.

Present industry surveys of Canadian consumer electronics indicate that about 80 percent of all the nation's homes have television, with even greater saturation for radios. Although no present alarm exists that tv sales will fall off or remain at present levels, indications are that many manufacturers would appreciate the increased sales that could come about if official circles showed more interest in color tv.

During 1959, Canadian sales of television receivers were 405,006. Heaviest sales were in the province of Ontario which accounted for 154,256, followed by Quebec with a total of 92,015. The less densely populated regions had lower totals, with Newfoundland having the lowest score, 8,858. These figures are for the entire 12-month period of last year as compiled by the Dominion Bureau of Statistics.

Although complete figures for 1960 are not yet available, some comparisons may be drawn from Dominion statistics for the eight months ended Aug. 31, this year. Total television receiver sales were 183,393. The same provinces accounted for the highest sales this period as they did last year. Ontario's figure was 67,864, Quebec's 49,771. Once more, lowest sales were in Newfoundland where 3,787 sets were sold for the year. Sales in other provinces were: Nova Scotia —8,444; New Brunswick and Prince Edward Island—6,383; Manitoba—11,807; Saskatchewan—8,369; Alberta—13,419; and British Columbia—13,549.

Statistics on radio sales for 1959 show a total of 770,000 receivers sold in the 12-month period. Of these, 360,051 were home sets, 103,437 were portables and 239,580 were auto radios. In addition, 67,217 radio-phonograph combinations were sold.

For the first eight months of this year 403,306 radio receivers were sold; 169,402 were home units, 59,681 were portables. There were 145,757 auto radios sold, and 28,466 radio-phonograph combinations.

In all radio categories this year, Ontario accounted for highest sales for the eight-month period with a total of 214,823. Quebec followed in second place with a total of 89,323.

Record players, including amplifiers, reached a total of 196,725 units during 1959. The Dominion figures for this category of consumer electronics took into account only those domestically produced. For the first eight months of this year, total record player-amplifier combinations were 85,004, also limited to those of domestic origin.

Going back two years to 1958, Canadian statistics on radio tube production indicate that 17,398,429 receiving tubes were produced in the country, for a value approaching $12½ million. In the same year, 7,762,119 tubes were imported at a value of $7,423,459. Last year, Canada produced 18,124,579 receiving tubes valued at $11,963,968, indicating a drop in unit cost due to rising production volume. During 1959, imports of receiver tubes rose over the preceding year to 9,167,653 at a dollar figure of $7,827,214.

For the first eight months of 1960, Canadian officials say the nation produced 8,822,250 receiver tubes worth $6,624,715 as against 4,304,640 units imported for a value of $3,277,941.

Television picture tube production for the January-to-August period of this year came to 464,594 units of which 398,008 were shipped for a sales total of $7,426,766.

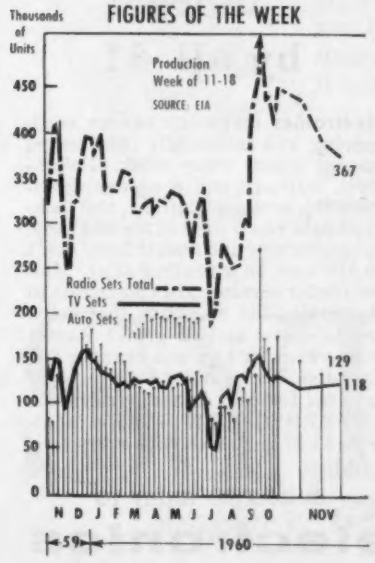
These figures do include rebuilt tv tubes.

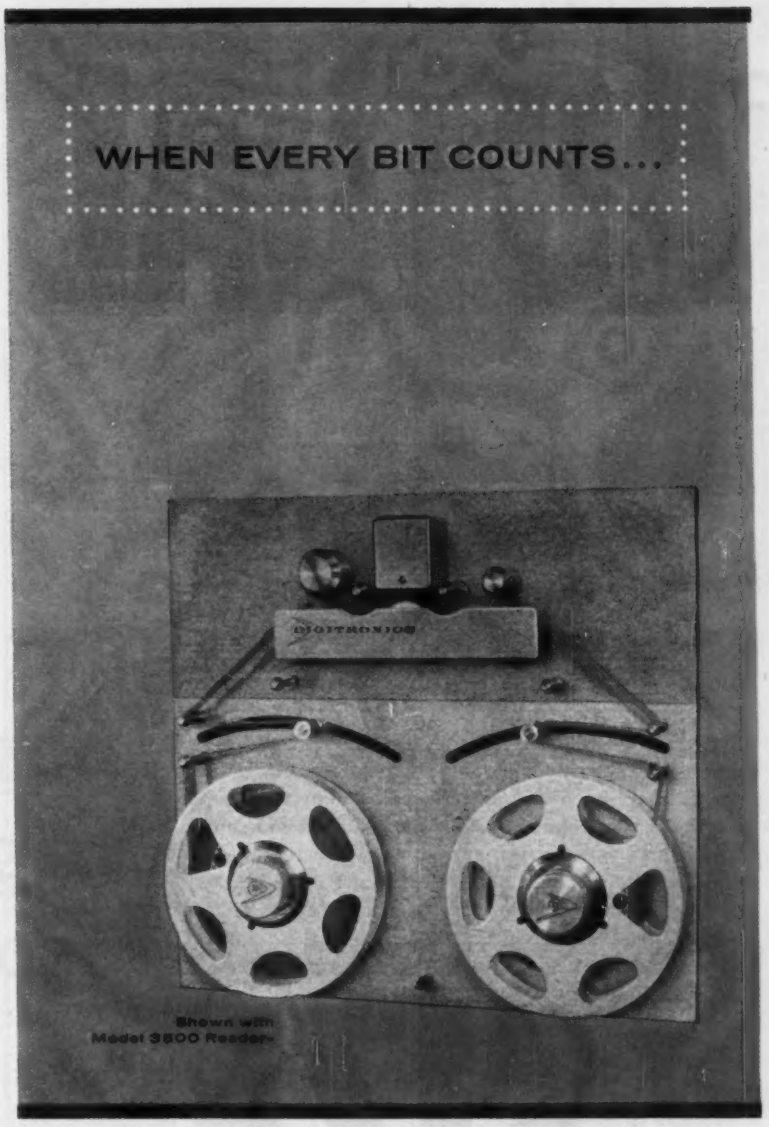
Creation of a nation-wide chain of associated, franchised stores to distribute electronic parts, high fidelity components and allied products was announced by Robert Laub, vice president of Lafayette Radio Electronics Corp., Jamaica,

N. Y. It will mark the first time that distribution through associate stores has been undertaken in this field.

The decision came as the result of successful test programs in Trenton, N. J., and Waterbury, Conn., which were initiated several months ago.

MARKETING APPOINTMENTS . . . **Steven Berck** appointed Manager of Marketing Services at Motorola Inc. Semiconductor Products Division, announces R. H. Rudolph, Manager of the Marketing organization. . . . The appointment of **Charles F. Thomas** to newly created post of Manager of Marketing and Planning for Radio Corporation of America was announced by D. Brainerd Holmes, Manager of RCA Major Defense Systems . . . **Duane Manning** appointed the new Marketing Manager for Elgin National Watch Company's Electronics Division, manufacturers of relays in Burbank, Calif. is announced. His responsibilities will cover all marketing functions, including sales, advertising and market research. . . . **Richard A. Fletcher** has been appointed Corporate Planner-Market Research at Lockheed Electronics Co., in Plainfield, N. J. . . . Election of **J. Gilbert Nettleton, Jr.**, vice president, director of marketing, for ITT Federal Division, Clifton, N. J., and ITT Laboratories, Nutley, N. J., is reported.





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ACTUAL SIZE

20 TO 30 VOLTS DIRECT CURRENT

TIMING FOR RELIABILITY of systems, sub-systems and modules is accurate, dependable with Houston Fearless "Alert" sub-miniature Elapsed Time Indicators. Measure life expectancy, provide operational warnings to prevent overuse failure. Tested for severe environmental use. Exceeds MIL-E-5272C. 1,000 and 10,000 hour models. Weight, 2 oz., 1" dia., 1¼" depth. Write for specifications.

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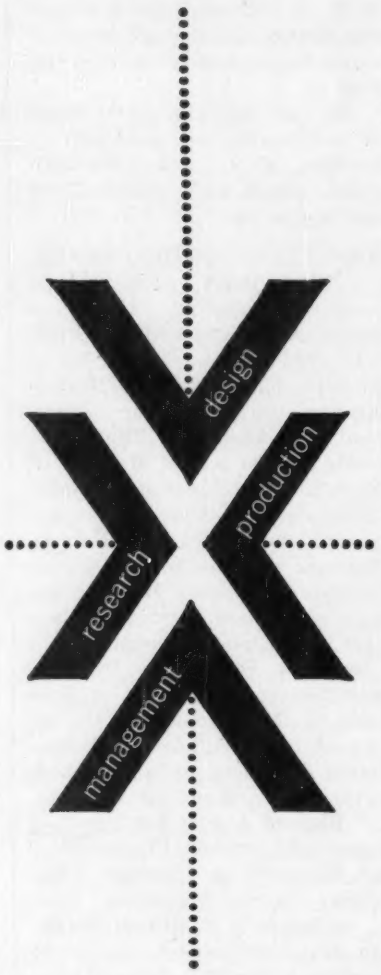

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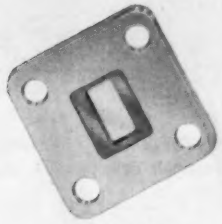
Microwave Component News from SYLVANIA

NEW

Sylvania's new XM-4218
⅜ actual size

Ka-band magnetron rugged, lightweight, low in cost

Designed for missile and airborne applications... mapping, surveillance, drones, fire control... this 25 kilowatt Ka-band unit operates at 33,000 ft. without capsule pressurization or potting compound. Corona problems are eliminated by a unique new ceramic cathode support design. The tube withstands 10 G vibration (50 to 2000 cycles), and meets military environmental specifications. It is extremely light in weight (approx. 4 lbs.) making it one of the lightest-weight medium power Ka-band tubes. Engineering samples are available.



WG-4223
actual size ¾" x ¾"

...with matching waveguide window

Made to operate with the new Ka-band XM-4218 is WG-4223... 32 to 37 kmc... 50 kilowatt peak power and 1.10 VSWR. It withstands 35 psig.

This is one of 29 Sylvania waveguide windows covering frequencies from 2.6 to 37 kmc. Both glass and mica windows are available. In addition to existing units, new types can be designed to specific requirements for applications from pressurized radar systems to microwave links.

• • •

For more information on these and other units in Sylvania's extensive line, wire or phone your nearest Sylvania tube sales office, or contact Sylvania Microwave Device Operations (formerly Special Tube Operations), 1891 East Third St., Williamsport, Pa.

SYLVANIA

Subsidiary of GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

RECENT RAYTHEON DEVELOPMENTS
IN MICROWAVE FERRITE DEVICES

BROADBAND COAX ISOLATORS FOR L&S BANDS

NEW COMPACT DEVICES PROVIDE MINIMUM ISOLATION OF 20 DB OVER EXTENDED BANDS

A single Raytheon L-band coaxial ferrite isolator now covers the full frequency range from 1,250 through 1,600 mc while its S-band sister covers the band from 2,000 to 4,000 mc.

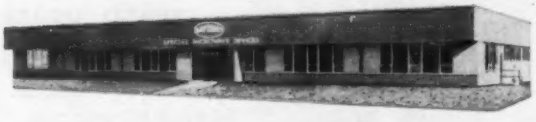
The new units, designated I_cLM3 and I_cSM2, open new design possibilities in L and S band equipment. Where performance over narrow frequency ranges is specified, increased isolation is possible with either unit.

To learn more about this significant development or other important Raytheon advances in microwave ferrite devices, please write, stating your particular area of interest, to the address below.

TYPICAL SPECIFICATIONS

	IcLM3	IcSM2
Frequency range	*1,250-1,600 mc*	*2,000-4,000 mc*
Isolation		
Minimum	*20 db*	*20 db*
Maximum	*40 db*	*31 db*
Insertion loss		
Minimum	*.8 db*	*1.3 db*
Maximum	*1.0 db*	*2.0 db**
Power		
Peak	*10 kw*	*5 kw*
Average	*25 watts*	*5 watts*
VSWR		
Minimum	*1.10*	*1.02*
Maximum	*1.25*	*1.25*
Weight (max.)	*3.8 lbs.*	*2.25 lbs.*
Max. dimension	*12 in.*	*9.8 in.*
Connectors	*Type N*	*Type N*

*1.0 db over narrow band.



THE MOST MODERN FACILITY devoted exclusively to microwave ferrite device and materials development, testing and production.

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WALTHAM INDUSTRIAL PARK
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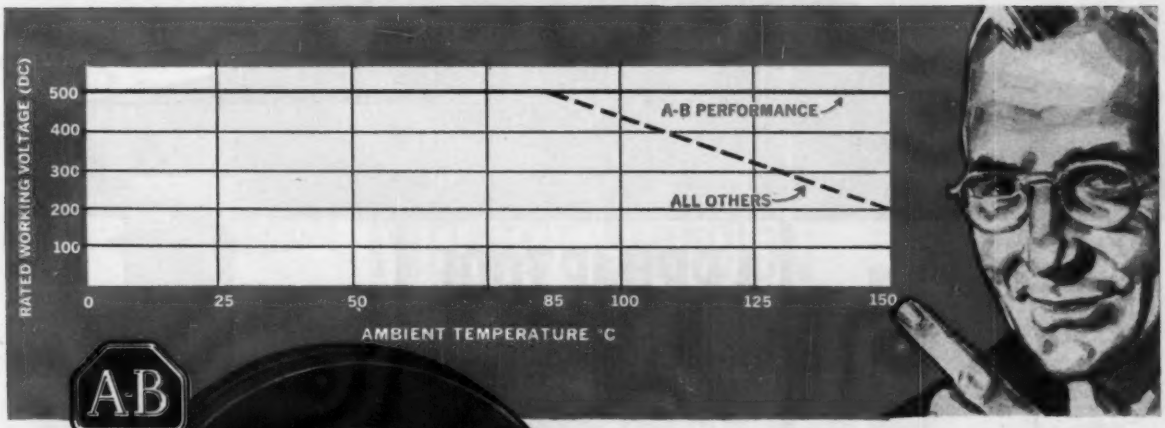
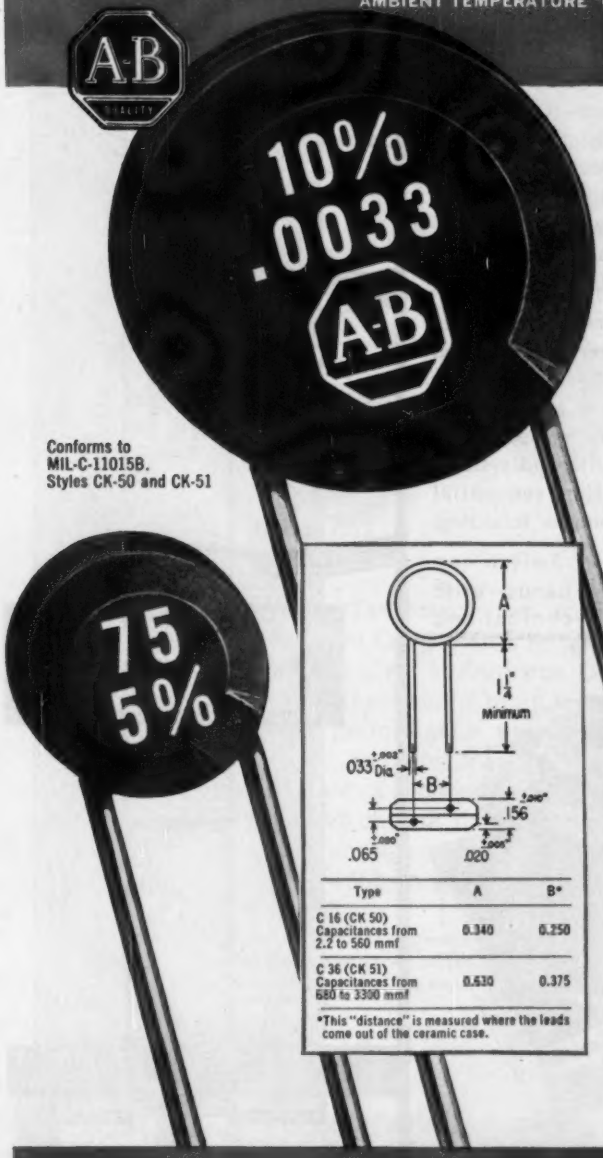
P. O. Box 152, Waterloo, Ontario

RAYTHEON *EXCELLENCE IN ELECTRONICS*





Conforms to
MIL-C-11015B.
Styles CK-50 and CK-51

Type	A	B*
C 16 (CK 50) Capacitances from 2.2 to 560 mmf	0.340	0.250
C 36 (CK 51) Capacitances from 680 to 3300 mmf	0.530	0.375

*This "distance" is measured where the leads come out of the ceramic case.

NO DERATING AT 150°C

ALLEN-BRADLEY CERAMIC ENCASED Ceramic Disc CAPACITORS

operate continuously at full rated voltage in 150°C ambient temperatures

The unique construction of Allen-Bradley ceramic encased, ceramic disc capacitors assures the *ultimate* in reliability and performance at all times! They will *never* exhibit erratic changes in capacitance and are free from catastrophic failures by open or short circuiting—even when operated continuously at the maximum rated voltage of 500 volts d.c. in 150°C ambient.

These A-B capacitors have a tough ceramic encasement that provides unusual dimensional uniformity and mechanical strength. There is no "boiling out" at high temperatures—and no "run-down" on leads to cause soldering problems.

Where superior performance *in all respects* is the prime consideration, you owe it to yourself to insist on A-B ceramic encased, ceramic disc capacitors. For full details send for Technical Bulletin 5400D, today.

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Magnetic orientation system undergoes tests in spherical cage

How Tiros II

Two-channel infrared radiometer weighs 1½ oz, operates on 50 microwatts

By JOHN F. MASON,
Associate Editor

TWO IMPORTANT INNOVATIONS in weather satellite techniques put the new Tiros II a big step ahead of its predecessor, Tiros I. The malfunctioning wide-angle tv camera in the new satellite, while disappointing from a reliability standpoint—it worked well in Tiros I—does not detract from the new satellite's two new capabilities.

Tiros II which went into an almost-circular orbit on Nov. 23 has an orientation-control system that makes its attitude managable from the earth and new infrared equipment for observing the heat balance of the earth and atmosphere.

Both additions are milestones toward perfecting the global system of weather satellites toward which the National Aeronautics and Space Administration is working. NASA's plan, before the successful launch, was to launch another Tiros next year, followed by a still more advanced series of four satellites, called Nimbus, to begin in 1963. NASA's weather-satellite money for next year is $18 million.

The Weather Bureau wants to accelerate the program and get one Nimbus into orbit and operational by 1962, and two more launched simultaneously in 1963. This would cost about $113,400,000. The Weather Bureau would also like to take over responsibility for launching and using the satellite after NASA develops them. Following Nimbus, plans call for the Aeros 23,300-mile-high stationary satellite.

The technique for controlling the orientation of the new satellite grew out of a study of the unexpected gradual attitude shift of Tiros I. The RCA team which designed and built both Tiros I and II for NASA discovered that the earth's magnetic field was tilting Tiros I away from the desired and predicted position of its axis.

In Tiros II, magnetic forces were generated and harnessed to tilt the satellite the way the ground observers wanted it. This was done by 250 turns of aluminum wire coiled around the lower sides of the vehicle. Interacting with the earth's magnetic field, ground observers could then tilt the satellite on command to obtain the most advantageous angle for the sensors and the solar power supply.

In developing the technique, RCA engineers devised a large spherical test cage in which the complete satellite was placed and rotated in a magnetic and solar environment similar to that in space. The control system weighs less than two pounds.

The new infrared equipment, designed and constructed by Barnes Engineering Co. under the direction of the Army Signal Corps and NASA, consists of two ir radiometers.

One of the instruments is a 2-channel, d-c radiometer weighing 1½ oz and requiring only 50 microwatts to operate. Nonscannable, it is aimed along a fixed axis, parallel to the cameras of the satellite. Its 50-degree by 50-degree field corresponds roughly to that of the satellite's wide-angle tv camera.

Two collecting lenses used are actually no more than thin plastic cones, coated with aluminum on one side and gold on the other. The white channel—white refers to the coating on the thermistor flake delicately poised on the thin strands of plastic fiber at the focal point of the lens—reflects visible light, but absorbs ir radiation. The black channel absorbs all radiation, ir and visible. The two values of radiation

Ground-Control and Infrared Gear Work

thus obtained permit scientists to calculate the earth's albedo—the ratio of ir radiation reflected by the earth to the total solar radiation the earth receives. At the same time, the radiometer also measures the earth's emitted radiation.

Construction of the 2-channel radiometer took place under a microscope. The plastic cones are 0.002-inch thick. The platinum detector lead wires, 0.0005 in. in diameter, were wrapped around the thin strands of plastic fiber and soldered to 0.001-in. in diameter wires.

The other ir radiometer is a 5-channel scanning device. (Both radiometers scan only because of the satellite's motion.) The field of view is six degrees by six degrees —approximately that of the satellite's narrow-view tv camera.

The five channels accommodate five separate detectors:

Channel 1 operates in the 6.3± 10 percent micron wave length; function is to receive radiation from strong water vapor emission; this yields temperature near the middle of the earth's atmosphere.

Channel 2 operates on from 0.55 to 0.75 micron; visible range; detects nature of cloud cover in the daytime. Response close to that of human eye; serves as reference for ir channels.

Channel 3, 0.2 to 5.5 microns; about 99 percent of solar radiation falls into this band; channel measures albedo of the earth (energy from the sun striking the earth, but not absorbed).

Channel 4, 7.5 to 30.0 microns; measures the earth's total emission, i.e. temperature of earth as viewed from the satellite.

Channel 5, 7.5 to 12.0 microns; atmospheric window; measures temperature of the earth or its cloud cover; looks through atmosphere in area where water vapor absorption and emission are low.

Each channel is capable of looking alternately in both directions. Infrared radiation and visible light entering each channel of the radiometer head from either side is deflected 90 degrees by a prism, and is reflected from a chopper mirror, then passes through a lens and filter before being absorbed by the thermistor detector.

Coated with ir absorptive paint on half their area, rotating mirrors stop ir energy received first from one, then the other side of the prism. This alternate reflection and absorption of the rotating mirror actually chops the received radiation, creating an a-c signal. This signal, developed by the thermistor detector, is then amplified, rectified and stored on magnetic tape, for playback on command.

The two radiometer windows were designed to be generally oriented in space so that one looks toward the earth and the other toward space. Because outer space temperature is constant, it will be used as an absolute reference point to calibrate indications of the earth's temperature.

The remainder of the satellite equipment is similar to that used in Tiros I, according to RCA. It includes: an ir horizon sensor with tape recorder, transmitter and power supply; nine sun angle detectors mounted around the satellite perimeter to determine the angle of the sun while pictures are being taken; two tv cameras—the wide angle, ½-in. vidicon camera intended to photograph an area of about 700 mi on each side, and the other narrow-angle version of the same camera which views an area about 80 mi on each side.

The blurred pictures being received from the wide-angle camera are not due to any electronic malfunction, RCA says. "The fault apparently lies in the optics or in some external phenomenon. The video response from the camera itself is being received as expected."

Each of the two tv magnetic tape recorders stores 32 tv pictures from its associated camera on each orbit until the readout command is received from a ground station.

Also common to both Tiros satellites are two electronic clocks to control the timing of operation by the cameras, tape recorders and i-f systems during each orbit; two two-watt f-m transmitters for tv and ir data; two beacon transmitters for tracking and transmission of telemetry and vehicle attitude data.

Power supply consists of 9,200 solar cells with outputs of 28 and 14 volts; 63 nickel-cadmium storage batteries, rechargeable from solar cell power.

Four transmitting antenna rods are mounted on the bottom of the satellite, forming crossed dipoles for all data transmission. One receiving antenna rod is mounted top center of the satellite.

The satellite is cylindrical, 42 in. (diameter), 19 in. deep and weighs 280 lb. It is expected to operate, like Tiros I, for about three months (1,300 orbits).

In the Tiros II ground system, one of the primary ground stations used for Tiros I was moved from Hawaii to the Pacific Missile Range with installations at Point Mugu, Calif. and on San Nicolas Island, 55 miles off shore. This new station, operated by the Navy for NASA is paired with the second main ground station operated by RCA and the Signal Corps at Fort Monmouth, N. J. The RCA plant in Princeton, N. J. serves as a backup station.

Ground station equipment consists of a programming system for presetting or direct initiation by command of various control operations and sequences for the satellite; master clock; two tv receivers equipped for picture display and photo recording of each image; tape recorders for recording both picture information and ir measurements; two telemetry readout stations, each with paper recorders for data; and computing systems.

NASA Computing Center at Greenbelt, Md. prepares and transmits programs to the ground stations. Minitrack stations in North and South America aid in tracking and position data. RCA Space Center computes orientation control and reruns original tapes from primary stations to enhance pictures for use at the Naval Photo Interpretation Center. Four agencies are receiving the Tiros pictures and ir data for processing and study: Naval Photo Interpretation Center, NASA's Goddard Space Flight Center, U. S. Weather Bureau, USAF's Cambridge Research Center.

Presidents Attend Finance Seminar

By THOMAS EMMA,
Associate Editor

LAST WEEK on Wall Street key men in the financial community were hosts to electronics company presidents in the first in a series of seminars.

Speakers at the Nov. 28 meeting represented an accounting firm, commercial bank, specialized investment company and management consulting firm. (A brief welcome was given by A. C. Simmonds, Jr., Chairman of the Bank of New York, where the group met.)

Indicating the basic purpose of the meeting, G. W. Spurr, Jr., assistant vice president of the host bank told the electronics men, "I think you have done a better job in helping us understand your business and its needs than we have in helping you know ours. We want to change that." The first speaker, K. S. Axelson of Peat Marwick Mitchell & Co., accountants, began by identifying some methods and sources of financing. He defined short and medium-term loans as supplied by banks, long-term loans as obtained from insurance companies and other institutions and equity capital financing as supplied by specialized lenders.

He outlined difficulties new electronic companies can have in financing because of inadequate and poorly kept records, failure to evaluate product profitability realistically, failure to keep adequate production cost records. He also mentioned lack of good controls to disclose improper use of funds.

Axelson also mentioned difficulties peculiar to the electronics industry such as management control in research and development and technological changes. He stressed the need for a strong financial executive, proper accounting procedures and staff, and a sound approach to procedure development. "I have seen small companies shoot up fast and retain payroll systems that were good for a 20-man shop, inadequate for a 60-man company and hopeless for a 150-man company. Here, initial company procedure is lacking. The executive talent must initially have an environment that will let it grow along with the company."

In his talk, Making the Most of Your Banking Facilities, G. W. Spurr, Jr., outlined some of the important differences between growth companies in electronics as compared with those in other fields. He pointed out that these differences have led banks to develop specialists to deal with credit requests from our industry. He also reviewed some minimum requirements and achievements a young electronics company must have to receive consideration for a commercial bank loan.

Spurr also discussed some basic forms of bank credit and their relative applicability to the unseasoned new electronics company. He noted that most such companies are not able to qualify for unsecured financing in their early years, but pointed out that other forms of bank credit were available. "The important thing," he said, "Is to have a well planned presentation and let the banker decide the amount and type of financing that will best serve."

Loans against the security of accounts receivable were also discussed and Spurr pointed out that many banks offer such credit. Here the strong credit standing of the prospective borrower's customers may be looked upon as balancing the weaker credit status of the borrower. With such security the banker is often in a position to help where he could not otherwise.

Still another type of bank accommodation that has particular application to the young electronics firm is assignment of claim financing under defense production contracts. Spurr pointed out that often this is the only avenue of financing open to the contractor or subcontractor substantially dependent on a feast or famine business. This is particularly true, said Spurr, in cases where long time intervals are involved. Because such claims do not in effect exist until delivery, the prospective borrower must be able to demonstrate to the bank his ability to perform according to contract specifications. Spurr added, "If you have a definite production prime or subcontract, or a letter of intent or purchase order, you should

Bankers Inspect Sorter-Reader

Electronic check sorter uses magnetic ink character recognition. Burroughs machine is at National Savings and Trust, Washington, D. C.

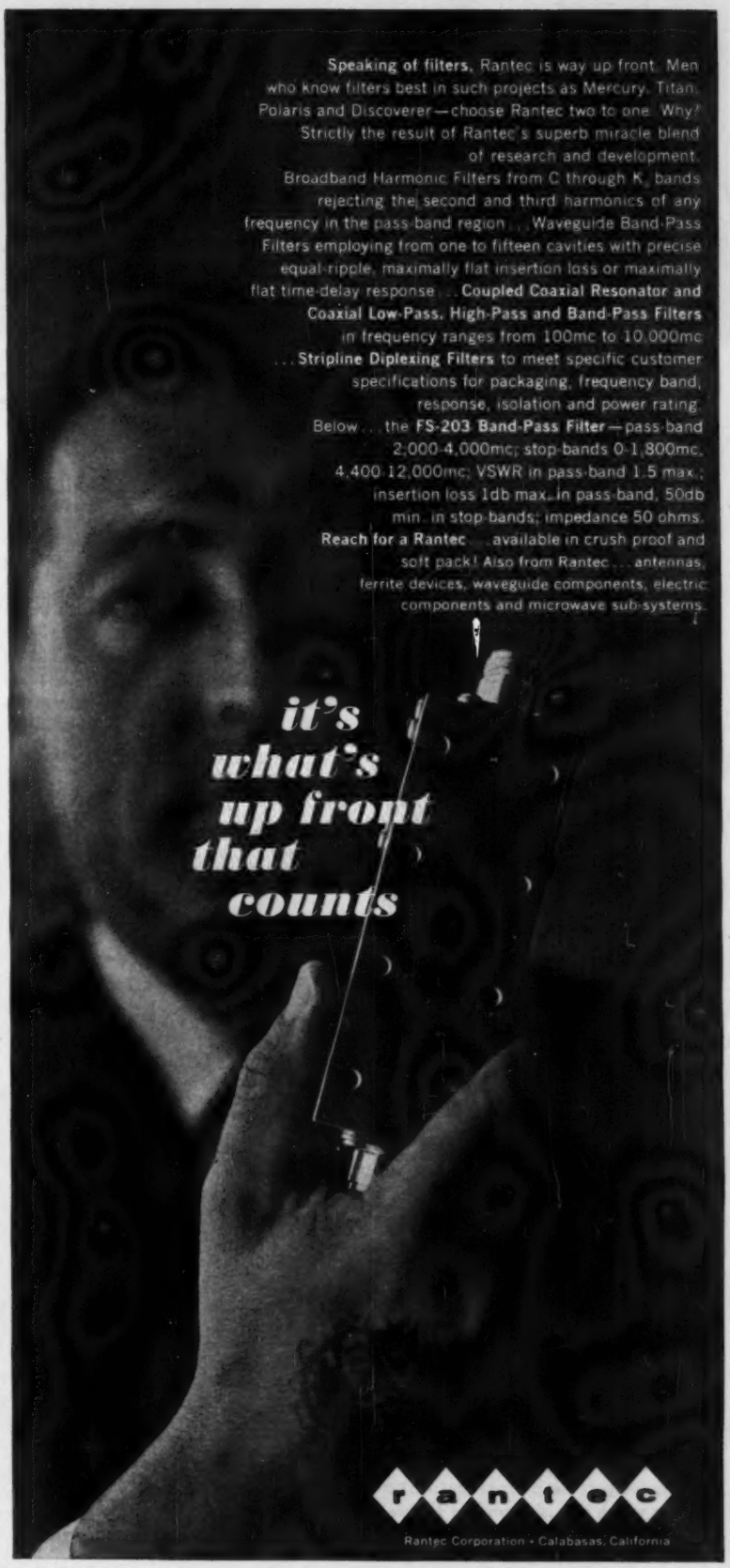
ELECTRONICS EXECUTIVES ATTENDING

Ad Auriema	Carlos Auriema, pres.
Alcar Instruments	Dr. Hugh Darby, pres.
Brooks Research	Robert Prisch, pres.
Diffraction Ltd.	Richard Miller, treas.
Dynamagnetics	George Sebesta, pres.
Electronic Energy Conversion	Dr. Richard Wouk, pres.
Gen'l Microwave	Frederick Zissu, bd. chmn.
Induction Heating Corp	Edward Goodrich, pres.
Isotronics Inc.	Russell Johnson, v. pres.
Kane & Co.	Martin Kaplan, v. pres.
La Voie Labs	Stephen La Voie, pres.
	Richard Laufer
Materials Electronics Products	Dr. Samuel Shapiro, pres.
Quan-Tech Labs	Fred Staemphli, v. pres.
	John Van Beuren, pres.
Trygon Electronics	Ira Kasindorf
Vernitron Corp.	Bernard Levine, pres.

certainly not hesitate to explore financing with a bank that knows its way around the industry."

Speaking on venture capital was D. C. Seibert, eastern regional investment officer of Electronics Capital Corp. He told the group that venture capital suppliers are prepared to take risks provided they see strong capital appreciation potential. He said this form of financing could be effectively used by companies with large growth possibilities that lack adequate long-term capital from other sources and which run significant major risks in their operations. Seibert said venture capital was not particularly suited for companies with little desire to grow rapidly, or with little inherent growth possibility.

Management consultant Stanley Simon, president of the company bearing his name, concluded the presentation with a talk on public financing. He spoke of such advantages as allowing companies to get partial diversification of capital and at the same time maintaining control and incentive in company growth. He added that key personnel join in company growth through stock option plans. Simon pointed out that costs of public financing to the small company are high relative to the amount of capital to be raised. He said fixed costs of $40,000 to $50,000 are the rule in even simple underwritings. With the addition of other expenses, Simon estimates a company seeking $500,000 would have to sell somewhat over $600,000 in securities.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HOW TO AVOID DEVELOPING A COMPULSIVE DESIRE FOR A DIGITAL COMPUTER

The computer we're warning you about is called Recomp. It looks innocent enough at first. Yet one glance can be enough to arouse your acquisitive instincts. Recomp is a handsome piece of equipment. Like fine architecture or jet plane design, it looks right because it is right; form fits function.

Something else that will appeal to your practical sense is the compact size of Recomp. It's solid state, of course; in fact, it was the first fully transistorized computer on the market. There are no voluminous rows of vacuum tubes; no ventilating problems. Yet many times Recomp can match the performance of computers that literally fill rooms.

Now, to indulge your natural desire to find out more about the finest computer in its class, just imagine you have a Recomp handy. First, plug it in; any wall socket will do, and it takes no more electricity than an ordinary electric toaster. After an appreciative look at that distinctive keyboard, try a few sample problems. You will have a full scale compiler named SALT (that's Recomp's own Symbolic Algebraic Language Translator) to help you, or you can use Recomp machine language which is the simplest of any computer on the market today. If you do not know how to operate the keyboard, never mind; in a few hours you can become an expert at programming Recomp. It doesn't even demand specialized talents; anyone with computer problems can be taught to do it.

While you're enjoying yourself at the keyboard, why not try a problem using floating point arithmetic? Of course, Recomp has it built-in; in fact Recomp is the only compact computer on the market today in which this is a standard feature. It is rather astonishing how much greater capacity this gives you to handle a wide range of problems. Cuts down on that frustrated feeling.

If, at this stage, you can already feel the first stirrings of an irresistible urge to possess Recomp for your very own, let us counsel you: this is just a premature impulse. First you should read this unembellished list of facts:

1] Exclusive built-in floating point arithmetic.

2] Easy to program.

3] Efficient programming; 49 basic instructions expandable to 72.

4] Fast access time due to high-speed loops.

5] Magnetic disk memory with large capacity—up to 8192 instructions.

6] Large word length of 40 binary bits.

7] Each word contains two instructions.

8] Solid-state reliability.

9] Built-in square root command.

10] Large sub-routine and program library.

11] Active users group.

12] Built-in automatic conversion from decimal to binary.

13] Visual display of any word in memory.

14] Simple correction of errors.

15] Easily installed anywhere.

16] Can use conventional teletype equipment.

17] Low cost per computation.

18] High-speed input and output.

19] Programming training provided.

20] Large program exchange.

21] Coast-to-coast sales & service.

No doubt you have read of other computers that claim many of these advantages, but you see, Recomp is the only one that can claim them all. This can be very disquieting when you think about it.

Now, as to how you can avoid developing a compulsive desire for a digital computer: don't see Recomp in action. For on seeing the performance of Recomp, it is quite likely you will insist on owning one. However, if you find that the insidious Recomp has made an ineradicable impression on you, it would be as well to face facts. The truth is, you need Recomp. We'll be glad to help. Our address is AUTONETICS INDUSTRIAL PRODUCTS, Dept. 125, 3400 E. 70th St., Long Beach, California. The Autonetics Division of North American Aviation, Inc.

Laboratory sample of GE's aluminum-aluminum oxide-lead sandwich (photo) is fabricated by vapor-depositing aluminum on glass in vacuum, oxidizing the aluminum in air and then vapor-depositing lead over aluminum oxide

Cryogenic Electronics Yields New Devices

DISCOVERY of quantum-mechanical tunneling in experimental thin-film devices (ELECTRONICS, p 11, Nov. 25) marks a new threshold in the technology of cryogenic electronics. This week, interest focused upon possible computer applications.

Researchers at Arthur D. Little, Inc. are emphasizing using the negative-resistance characteristic of the supercooled metal-dielectric-metal sandwiches. Application of this phenomenon is expected to lead to devices compatible with the thin-film cryotron (ELECTRONICS, p 84, Oct. 14). Thus, the new devices, called tunneltrons by ADL, may find application in computer switching and memory circuits as well as cryogenic low-noise amplifiers and high-frequency oscillators.

One possible application is as readout devices for cryotrons in computer logic circuits. This would use the switching capabilities of the device, taking advantage of resistance ratios on the order of 10^5 at temperatures of 2 K.

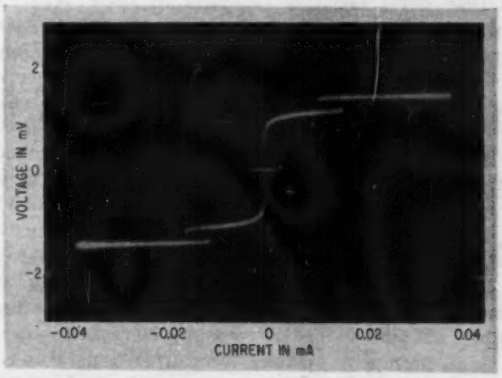
Unlike the same effect in the tunnel diode (ELECTRONICS, p 54, Nov. 6, 1959), the characteristic of the so-called tunneltron is independent of the applied voltage. Furthermore the device, whose operation is anticipated as being "well into the microwave region", requires power in the millimicrowatt range, can be controlled by the application of magnetic fields and may have advantageous noise and production features. However, the narrowness of the tunnel current region may be an inherent limitation.

Tunneltron samples have been prepared by evaporating an aluminum strip onto a glass substrate, oxidizing in air to form an aluminum oxide surface layer on the order of 10^{-7} cm thick and then evaporating a lead cross strip over the insulating layer. Area of the crossing is approximately 1 square millimeter.

Besides experimenting with aluminum and lead, GE has studied indium and tin at temperatures between 0.9 and 4.2 K. In most experiments, aluminum oxide has been used as the insulating film, although tunneling has been found in tantalum oxide, niobium oxide and nickel oxide as well. GE foresees the possibility of using the device as a switch, diode, negative-resistance diode, triode, resistor or capacitor.

An IBM spokesman reports that his company is working on tunneling in superconducting thin films but is not at the stage where it is ready to discuss devices or circuits.

Details of the tunneling phenomenon and experimental devices are reported in separate articles by I. Giaever of General Electric Research Laboratory and J. Nicol, S. Shapiro and P. H. Smith of Arthur D. Little's advanced research division in the Nov. 15 issue of *Physical Review Letters*.



Symmetric I-V characteristic is obtained in A. D. Little device with lead and aluminum at 1 deg K

What Are Your Sales Reps Really Thinking?

By PAUL PHILLIPS,
Director of Sales Promotion,
Valor Instruments, Inc., Gardena, Calif.

GETTING ALONG with your sales reps can cause problems. Valor Instruments, Inc. has just completed a survey designed to find solutions.

The private thoughts of your sales reps about you can be the real reason sales are anemic, instead of being fat, fine, and full of vitamins. The products of a manufacturer can be the finest, but sales are not going to climb if the real, inside opinion his reps hold of him as a principal is not a good one.

Reps are not just complainers. The most heartening thing the survey revealed was the eagerness they show in wanting the right relationship of confidence and understanding, a two-way street of trust between themselves and their principals.

Our real competition is merely the other lines our sales reps are carrying. Actually, we are competing only for a bigger share of our reps' time and efforts. That's seeing it clearly.

If the rep likes us, you can bet we get more of his time and effort! And this good opinion of us can be built only by servicing him to the hilt, by conveying our faith in him, by showing him we want him to make money and helping him do it.

According to reps themselves, here are the major mistakes made by manufacturers:

1. **Slow payment of commissions causes slow burn.**

Reps get burned up waiting for those "chips that never come in". The survey shows commissions are being paid much too slowly to reps. Not paying on a regular schedule is a widespread fault among manufacturers. Some principals show an amazing amount of unconcern on this point.

Not every rep has heavy personal capital. It's only decent consideration to realize his expenses are going on all the time, he needs his money on time. Today his expenses are much higher, his staff is larger. Not paying him promptly makes the rep feel as if he is expected to carry the manufacturer, a feeling not conducive to his good humor.

2. **Who buried that price quotation?**

Reps say they often think the factory has hired a Vice President in Charge of Neglect—a guy who specializes in delaying price quotations.

The survey reveals that many manufacturers put no emphasis or special effort whatever on speeding price quotations to reps. One principal admits he oftens runs as much as three weeks behind in answering. When reps ask for price quotations, they want them right now. Otherwise, they risk losing their order.

3. **Deliveries a muddle—and the rep in the middle!**

Reps say this is a major cause of concern to them: the factory's failure to meet promised delivery dates—and not letting the rep know about expected delays. Delivery promises that are careless, unrealistic, too optimistic. This puts the rep right out on a limb.

Reps by the dozen told us of the unhappy event that really makes them go wild . . . when the factory finds it can't meet a delivery and then notifies only the customer.

Reps want to be kept up-to-the-minute on delivery status and they want copies of all messages and letters from principals to their customers.

4. **Dear Principal: your last visit was exquisite.**

But when will we ever see you again? The survey showed that principals are not making enough visits to their reps. Reps report that they last saw some of their principals two years ago, some four years ago. Some never.

Reps resent it because it hurts their business. They want the principal, or a competent factory man, to visit them at least twice a year. And always with advance notice, so that effective calls on customers can be set up properly.

If visits to each rep are not practical, then sales seminars should be set up near the rep's territory. Reps want the factory men we send to be mature, to know everything about the products, and also to be men who have had sales experience themselves.

Over and over reps told of the immense help these visits are to them, in consummating important deals, in providing needed product training for the rep and his staff, and in the increased faith and understanding in each other gained by rep and principal alike.

5. **Reps pleading for product applications news.**

Reps say that manufacturers are expecting miracles from them on new business yet don't send them facts and news on product applications to help them locate new customers. They plead for a set-up where all the reps serving a principal would receive the details of every significant sale made by any one of his reps. They want the manufacturers to communicate the information and data of every new and special application of his products, so they can profit by what the other rep did.

They want every last bit of information the manufacturer knows or can find out about:

Who is buying the product. How they are using it. New projects and programs the product could be used in. What features of the product helped most to close other sales. Names of companies in the rep's area likely to use it.

Giant Gun Aids Research

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Phosphate (PO_4)	0.0001%
Sulfate (SO_4)	0.0001%
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Copper (Cu)	0.00001%
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Maximum Limits of Impurities

Residue after Evaporation	0.020%
Free Acid (as H_2SO_4)	0.010%
Chloride (Cl)	0.0005%
Nitrogen Compounds (as N)	0.005%
Phosphate (PO_4)	0.003%
Sulfate (SO_4)	0.005%
Arsenic (As)	0.00001%
Heavy Metals (as Pb)	0.0001%
Iron (Fe)	0.00005%
Preservative (Phenacetin)	0.035%

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H_2O_2 **M.W. 34.02**

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Assay (H_2O_2)	29.0–32.0%
pH	2.5–3.5

Maximum Limits of Impurities

Residue after Evaporation	0.002%
Free Acid (as H_2SO_4)	0.003%
Chloride (Cl)	0.0005%
Nitrate (NO_3)	0.0005%
Phosphate (PO_4)	0.00025%
Sulfate (SO_4)	0.0005%
Ammonium (NH_4)	0.0005%
Heavy Metals (as Pb)	0.0001%
Iron (Fe)	0.00005%

Hydrogen Peroxide, 30% "Stabilized" **Code 2775**
H_2O_2 **M.W. 34.02**

Assay (H_2O_2)	29.0–32.0%
pH	3.0–3.5

Maximum Limits of Impurities

Residue after Evaporation	0.03%
Free Acid (as H_2SO_4)	0.005%
Chloride (Cl)	0.0005%
Phosphate (PO_4)	0.020%
Sulfate (SO_4)	0.001%
Heavy Metals (as Pb)	0.0001%
Iron (Fe)	0.00005%

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BAKER & ADAMSON® "Electronic-Grade" Chemicals

TWO OUTSTANDING
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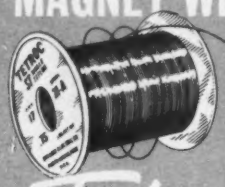
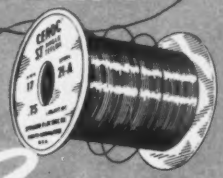


Tetroc®

FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO 200°C



Ceroc®

FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO 250°C

For continuous operation at hottest spot temperatures up to 200°C (392°F) and up to 250°C (482°F) for short periods of time—depend upon TETROC—an all Teflon-insulated wire available in both single and heavy coatings.

CEROC is Sprague's recommendation for continuous operation at hottest spot temperatures up to 250°C (482°F) and up to 300°C (572°F) for short periods of time. Ceroc has a flexible ceramic base insulation with either single silicone or single or heavy Teflon overlays. The ceramic base stops "cut-through" sometimes found in windings of all-fluorocarbon wire. Both Tetroc and Ceroc magnet wires provide extremely high space factors.

Write for Engineering Bulletins 405 (Tetroc Wires) and 400A (Ceroc Wires).

SPRAGUE ELECTRIC COMPANY
35 Marshall Street, North Adams, Mass.

SPRAGUE®
THE MARK OF RELIABILITY

Drum Routes Messages

System designed for British Admiralty may find use by other military and commercial organizations

AUTOMATIC routing of telegraph messages at 83,000 words a minute is accomplished by an electronic switching system exhibited last month at the International Air Transport Association meeting in New York. STRAD (Signal Transmission, Reception and Distribution) was developed by ITT's British affiliate, Standard Telephones and Cables Ltd. of London.

The system receives telegraph messages from up to 108 circuits and stores them on a magnetic drum before sorting them according to destination. The system retransmits them in order of priority and time of arrival. Strad is intended for organizations having a large flow of teleprinter traffic.

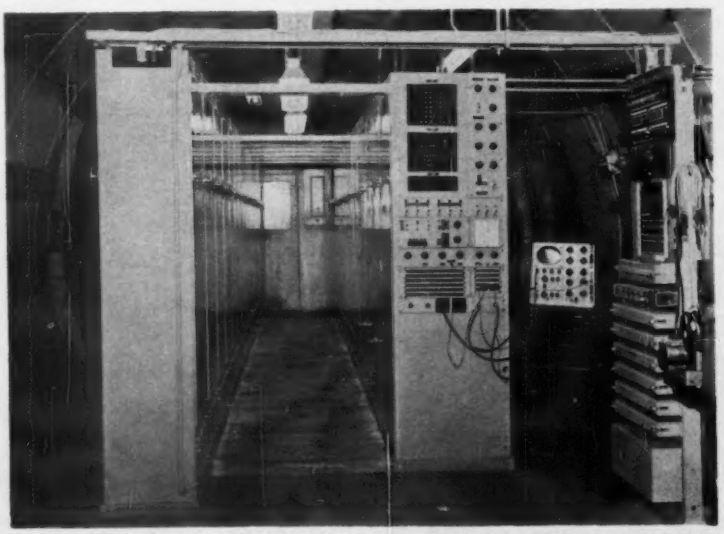
Heart of the system is a low-speed magnetic-drum memory for the system's control circuits that also stores incoming intelligence.

Messages are received at up to 2,400 bits per second. Recorded character by character on the incoming-line tracks of the drum associated with each line, the messages are then transferred to the central message store of the drum at 50,000 bits a second (83,000 words a minute) to release the incoming-line tracks for other messages.

Control circuits constantly monitor each outgoing line for availability. Upon finding a free line, the control equipment interrogates the drum's central message store for all messages requiring that line. The equipment also checks the priority and arrival time of messages so that they can be retransmitted in proper sequence.

Input and output-line circuits (shift registers) are buffers between the relatively low speed lines and the higher speed incoming and outgoing-line tracks of the drum.

The system uses time-sharing to transmit the same message over a number of lines at the same time. It can distinguish between six dif-



Automatic telegraph switching system installed at the British Admiralty

Automatically

ferent priority classifications.

To insure that traffic is neither lost or duplicated, incoming and outgoing page printers record messages passing through the system. A waiting register allows personnel to observe messages stored in the drum.

When the central storage occupancy increases above a predetermined level because of abnormal traffic overload conditions or line interruption, traffic can be selectively and automatically transferred to a magnetic tape storage. This overflow device also provides long term storage in installations where it is required to retain a copy of every message.

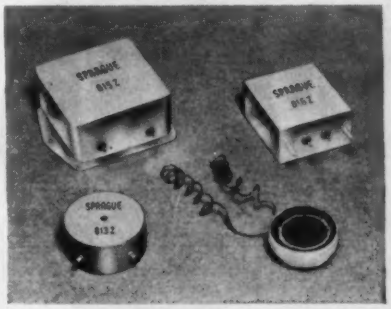
Because time-sharing is used, extensive dislocation of service could result from a fault in one of the common circuits. Therefore, circuit duplication with cross-checking is used to isolate, disconnect and indicate any common circuit that develops a fault. Plug-in units permit work on faulty units to proceed without disrupting service. Use of wire-wrapped connections avoids trouble from dry joints (high-resistive connections) due to imperfect soldering or wire fractures.

The line terminal conditions for Strad are unrestricted. The system is designed for duplex channeling. Lines and trunks both have independent send and receive channels. Either manual keyboard transmission or automatic transmission may be used. Lines can be associated with one or a number of stations.

According to ITT, several government agencies in the United Kingdom, Australia, Canada and Europe have ordered Strad systems. In the U. S., the system is marketed by ITT's Intelex Systems division. Applications of the system exist not only in telegraphy, say ITT representatives, but in many fields where information is to be collected from a number of remote points for processing and analysis, including data processing. Civil aviation ground communications at Gatwick Airport in London incorporate the system.

(Advertisement)

New Line of Precision Toroidal Inductors For Practically Every Application



Designed for use in commercial, industrial, and military apparatus, Sprague Precision Toroidal Inductors are customarily supplied to the close inductance tolerance of ±1%. The broad line of Sprague inductors includes such styles as open coil, plastic-dipped, rigid encapsulated types with tapped or through-hole mounting, and hermetically-sealed inductors.

All styles, with the exception of the open-coil type, meet the requirements of Specification MIL-T-27A.

Several core permeabilities may be obtained in each of the five basic sizes of Sprague inductors to give the circuit designer the optimum selection of desired Q and current carrying abilities. Each of the core sizes is available with several degrees of stabilization. Inductors made with cores which have not been subjected to the stabilization process exhibit low inductance drift with time and have a low temperature coefficient of inductance. Where a greater degree of permanence of characteristics is required, cores with two different stabilization treatments can be used for most types of inductors.

Sprague toroidal inductors may be operated from −55C to +125C. Temperature cycling of finished inductors is a standard production procedure in order to equalize internal stresses and insure permanence of electrical characteristics.

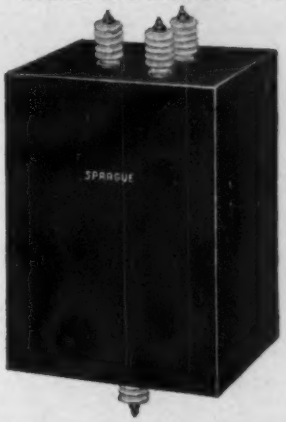
For detailed information on Sprague Precision Toroidal Inductors, write on company letterhead for portfolio of engineering data sheets to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

CIRCLE 200 ON READER SERVICE CARD

PULSE-FORMING NETWORKS

FROM WATTS

to MEGAWATTS



. . . and everything in between!

When it comes to pulse capacitors and pulse-forming networks, many complexities in parameters and design factors must be considered. These specialized units must be designed and manufactured by a specialized organization. And because Sprague maintains a highly-technical special engineering section devoted exclusively to pulse capacitors and networks, it has been, from the very beginning, a major supplier of these complex units for radar equipment (ground, marine, aircraft, missile), tube testing, and similar pulse circuit applications.

This special engineering section performs four important functions: One group *designs* custom units in accordance with required parameters. Another group *builds* pulse capacitors and networks to precise specifications. In another area, a group of specially-trained field engineers *provides application assistance* wherever needed. And yet another independent group *works toward the future* developing new materials, new design concepts, and new techniques for manufacture, enabling Sprague to introduce product improvements such as heliarc sealing of cases, rugged alumina bushing assemblies, Fabmika® dielectric, and improved hermetic sealing of closures.

Write for Engineering Bulletin No. 10,001 to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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CIRCLE 47 ON READER SERVICE CARD

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CIRCLE 49 ON READER SERVICE CARD

Patient uses dual control knobs to mix white noise and music as a way of reducing pain of dentist drills and pliers (Ritter Co.)

Audio May Reduce Dental Pain

THIS WEEK in New York participants in the 36th annual meeting of the Dental Societies of the State of New York saw new entrants in the field of electronic analgesia, a field practically nonexistent a year ago.

The pain suppression technique uses audio frequencies to counteract the pain and unpleasantness of the dentist's drill. It uses a sound source (usually tapes or disks), amplifiers and headphones.

This gear along with patient-operated controls completes the basic requirements.

Since the initial experiments, more than half a dozen companies have begun to manufacture the equipment for commercial sale. Among these, the Ritter Company, Rochester, N. Y., produces the Audio Analgesiac, or Audiac. Provided with the electronic equipment is a selection of music on tape cartridges including special programs for children. The patient holds a small control box whose two knobs allow him to choose his own blend of music and white noise. Also in the field is Cavitron Equipment Corp., Long Island City, N. Y., producing the Audio-Sonic. This equipment includes a chairside dentist's control, a patient control, earphones for both and a remote master unit. A selection of four music tapes is included with the equipment in cartridge form. The package lists at $750.00. Both companies exhibited at the New York dental meeting.

The Wilton-Greene Corp. of Ridgefield, Conn., also showed audio analgesic equipment at prices ranging from about $450 to about $1,200. Among contenders for the market is North American Philips with a system ranging in price from $1,000 to $1,500. The Philips equipment was exhibited in New York this week. Also exhibiting was Densco of Denver, Colorado.

The companies say they are now selling the equipment through dental supply houses and plan to continue this method because of the specialized market.

To date, the American Dental Association has neither accepted nor rejected the new pain reducing technique. Presently, the ADA's Council on Therapeutics is studying the method.

Guide for Graduate Engineers

GRADUATE STUDY at engineering schools is periscoped in a new publication put out by the American Society for Engineering Education at the University of Illinois (Urbana, Ill.). Running only twenty pages, the booklet presents information on planning graduate study (including reasons for taking graduate work), the kinds of degrees available, and the life of a graduate student. The aim of the authors is to give information that would apply to graduate study at any accredited engineering school in the U. S. The booklet is prepared by students in the University of Illinois chapter of Tau Beta Pi. It has the students' approach throughout. One section deals with what graduate study requires of the student, another tells how to choose the right school for the individual student's needs. For the married student, there is a section on housing, job for the wife and similar problems he may have to solve. A detailed section on financial support outlines the types of support available, and the advantages and disadvantages of each; it emphasizes that the engineer qualified for graduate study should have no trouble getting needed financial assistance.

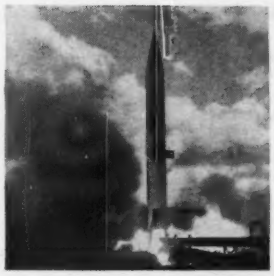
Builder of low-voltage electron microscopes, Dr. Alvar P. Wilska, is now a visiting professor of physics at the University of Arizona. Of his latest microscope, the fifth in a series built since 1950 in Finland, he said that lens improvement combined with low voltage may make it possible to visualize living structures down to the level of individual atomic groups. High contrasts are obtained, using as little as a quarter of the voltage required by conventional instruments.

U. S. participation in the North Atlantic Treaty Organization Fellowships in Science will again be administered by the National Science Foundation at the request of the State Department.

About 50 fellowships will be awarded to U. S. citizens in the sciences including the mathematical, physical and engineering sciences. Applicants must have earned a doctoral degree by the anticipated beginning of fellowships, or they must have had research training and experience equivalent to that of a doctoral degree. April 3, 1961 is the date set for making the awards. Encouragement to study in a country affiliated with NATO is an earmark of the program. However, fellows are not restricted to these countries, and consideration will be given to those planning study elsewhere.

Management decisions about the amount of money allotted to research and development during a specific planning period may be improved through a manual developed by operations research scientists at Case Institute of Technology. The manual recommends how money should be divided between the kinds of research and development, and the amounts to be spent on specific research and development projects for the firm. Based on a study of the effect of research on profits in several chemical companies, the formulas developed are offered as a suggested means for testing in other industries. One of the principal values of the formulas, says the Case group, is that they alert companies to the kinds of data that are essential for making rational decisions in budgeting research. Men with limited mathematical training, they say, can make ready use of the manual.

A Radio Astronomy Institute has been formed at Stanford University to implement an extended research program in which visiting scientists will take part. Emphasis will be on basic research in solar-terrestrial physics, galactic radio astronomy, radio interferometry, radiometry and related areas. Institute director is Professor Ronald N. Bracewell, who designed and built the 32-dish radio telescope now being used for sunspot and solar brightness studies.



IMPORTANT NEW OPENINGS FOR CREATIVE ENGINEERS

The Martin Company, at Orlando, Florida — prime contractor for Pershing, Bullpup, Lacrosse, Missile Master and BIRDiE — has senior level openings on its Technical and Research Staff in the following technologies:

- **Operations Research** — including optimum decision and prediction methods for existing and proposed weapon systems.
- **Information Theory**—with emphasis on optimum coding and signaling techniques.
- **Digital Computers** — analysis and advanced research, including learning machines.
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- **Inertial Guidance**—conceptual and analytic investigation of advanced systems using novel components.
- **Electronic Packaging** — utilizing thin film and micro-electronic technology.
- **Environments** — study of shock, vibration, acoustics, temperature, and natural environments.
- **Structures** — development of new concepts, materials, applications, and design criteria.
- **Human Factors** — analysis related to military and space applications.
- **Missile Propulsion** — liquid and solid rocket propulsion and air breathing systems.
- **Ground Support Equipment**—with emphasis on mobile missile systems.

If you are qualified for senior level work in this highly select staff, please send a brief resume to Mr. C. H. Lang, Director of Employment, The Martin Company, Orlando 23, Florida.

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At 00h00m01s GMT, December 1, 1960, Martin logged its 757,380,000th mile of space flight

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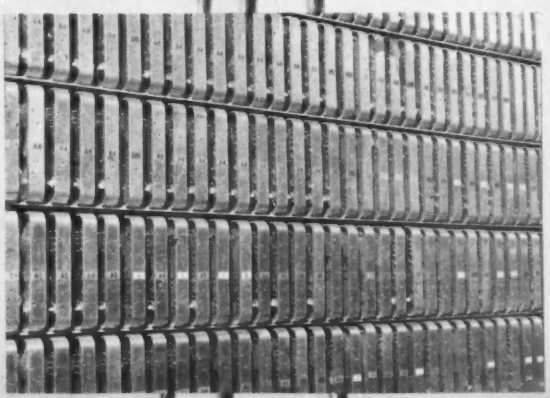

Back of HITAC 103.

Hitachi, Ltd.
Tokyo Japan

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ALL-TRANSISTORIZED DC VOLTMETER

ACCURACY TO ±.05% +5 UV ABSOLUTE for $475.*

MODEL DC-100A PRECISION VOLTMETER

The CSC Model DC-100A is a precision D.C. Voltmeter that combines an extremely wide measurement range with a high degree of accuracy and stability... for use from general production testing to precise lab calibration. With the DC-100A, you get a lightweight, portable instrument that's *self-calibrating*, fully transistorized and ready for use the moment it's turned on.

Additional specifications of note are:

RANGE: 0 to 1000 volts D.C.

STABILITY: ±.05% from 100 to 130 V.A.C.

LINE VOLTAGE: 117 V.A.C.—60 cps—less than 3 watts

WEIGHT: 9 lbs.

SIZE: 8" w., 7" h., 6" d.

The Model DC-100A is one of a comprehensive line of all-transistorized CSC precision voltmeters, volt-amp meters wheatstone bridges and regulation monitors. *For complete information and technical specifications, contact any of the CSC Representatives (shown at the right) or write directly to CSC for technical bulletin E-1314-1A.*

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CIRCLE 201 ON READER SERVICE CARD

MEETINGS AHEAD

Dec. 11-15: American Nuclear Society, Winter Meeting, ANS, AIF; Mark Hopkins Hotel, San Francisco.

Dec. 12-14: USA National Committee, URSI, Fall Meeting; National Bureau of Standards, Boulder, Colo.

Dec. 13-15: Eastern Joint Computer Conf., PGEC of IRE, AIEE, ACM; New Yorker Hotel, New York City.

Dec. 16-17: Combined Analog Digital Computer Systems Symposium, Simulation Councils, Inc., General Electric; Sheraton Hotel, Philadelphia.

Jan. 8-12: Thermoelectric Energy Conversion, Dept. of Defense, Joint Technical Society; Statler Hilton Hotel, Dallas.

Jan. 9-10: Plasma Dynamics; Southern Methodist Univ., Dept. of Mech. Engineering, Dallas.

Jan. 9-11: Reliability & Quality Control, ASQC, AIEE, EIA, PGRQC of IRE; Bellevue-Stratford Hotel, Philadelphia.

Jan. 12-13: Reliability of Semiconductor Devices, Working Group on Electron Tubes; Western Union Auditorium, New York City.

Jan. 17-19: Instrument Automation Conf. & Exhibit, ISA; Sheraton-Jefferson Hotel, Kiel Auditorium, St. Louis, Mo.

Feb. 1-3: Military Electronics, PFMIL of IRE; Biltmore Hotel, Los Angeles.

Feb. 1-4: Electronic Representatives Assoc., Annual Convention; Ambassador Hotel, Los Angeles.

Feb. 15-17: Solid State Circuit Conf., International, PFCT of IRE, AIEE; Univ. of Penn. & Sheraton Hotel, Philadelphia.

Mar. 20-23: IRE, International Convention, All PG's; Coliseum & Waldorf-Astoria Hotel, New York City.

ALL-TRANSISTORIZED VOLT-AMP METER

VOLTAGE AND CURRENT ACCURACY to ±.05% & ±.1% for $625.*

MODEL VA-100A PRECISION VOLT-AMP METER

The CSC Model VA-100A precision volt-amp meter combines all the features of the Model DC-100A voltmeter —such as wide range, high accuracy, extreme stability and *self-calibration*— plus a current measurement capability to an accuracy of better than ±0.1%. It is designed for standard lab calibration, general testing and production testing, and performs to the following typical specifications:

RANGE: 0-1000 Volts
0-1 Amp

VOLTAGE ACCURACY: ±.05% + 5 uv absolute

CURRENT ACCURACY: ±.1% + .001 ua

WEIGHT: 9 lbs.

SIZE: 8" w., 7" h., 6" d.

Complete information is available from any of these CSC Representatives:

QED Electronic Sales, Inc.....Mt. Vernon, N.Y.
Holdsworth & Company.....Lansdowne, Pa.
Stanley Enterprises.....Seattle 8, Wash.
Smith-Dietrich Sales Co.....Inglewood, Calif.
N. S. Brown Associates.....Dallas 30, Texas
The Jay Company.....Arlington, Va.
Charles Winick Company.....Schenectady, N.Y.
Frazar & Hansen (Export)..San Francisco 11, Calif.

Or write directly to CSC for technical bulletin E-1314-1B.

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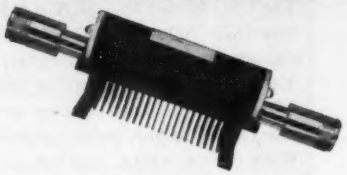
CIRCLE 53 ON READER SERVICE CARD

AVAILABLE NOW

SOLID STATE MATERIALS

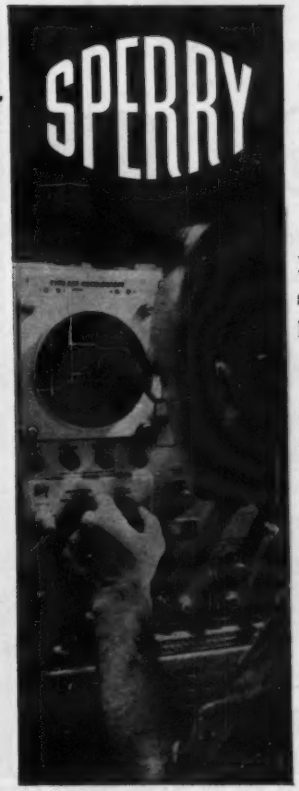


Materials capability assures superiority

Eight years of intensive research and development on solid state microwave devices, utilizing its fully-equipped ferrite materials laboratory, enable Sperry Microwave Electronics Company to offer the most advanced devices and materials yet developed by the industry.

Yttrium and yttrium gadolinium garnet standard bars are now available for early delivery. These advanced materials, with their consistent composition and characteristics, make possible more advanced solid state devices than were heretofore available.

Microline Instruments | *Radar Test Sets* | *Systems Instrumentation* | ***Solid State Devices and Materials*** | *Microwave Components and Antennas*



of SPERRY *solid state devices*

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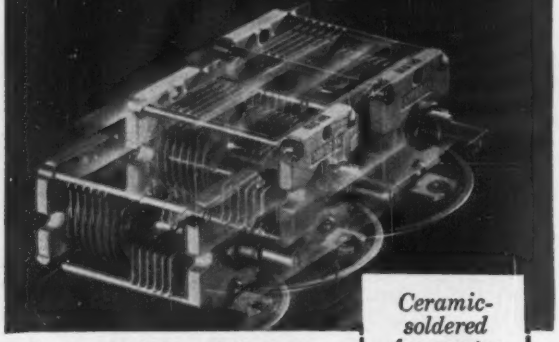

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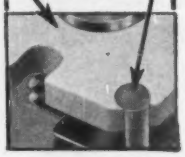

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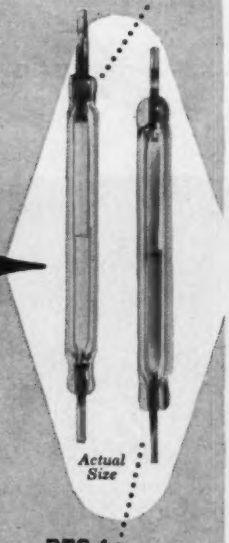

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Invited and contributed papers will contain the latest results of research in industrial and government laboratories and will cover all aspects of this important new field. Many of the invited papers will be tutorial to allow participants to make firsthand judgments about the state of this new science. A detailed program will be published well in advance of the conference.

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R. G. KEPLER, *E. I. DuPont de Nemours & Co., Conductivity in Anthracene Single Crystals*
JAN KOMMANDUR, *National Carbon Research Laboratories, Characteristics of Charge-Transfer Complexes*
OLIVER LeBLANC, *General Electric Research Laboratories, Interpretation of Conductivity in Molecular Crystals*
HERBERT A. POHL, *Princeton University, Electrical Properties of Pyrolyzed Polymers*
MARVIN SILVER, *Office of Ordnance Research, Surfaces and Contacts in Organic Semiconductors*

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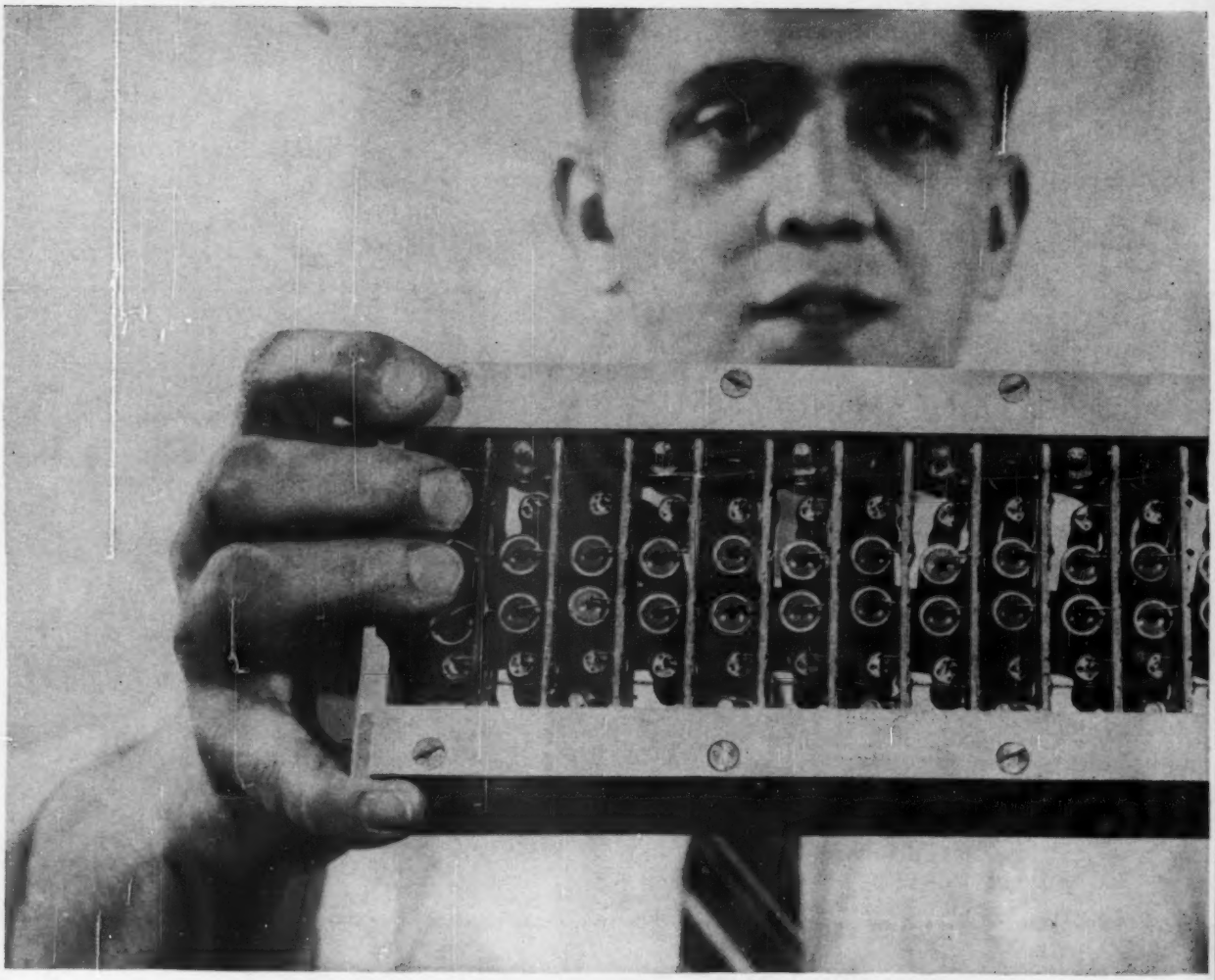

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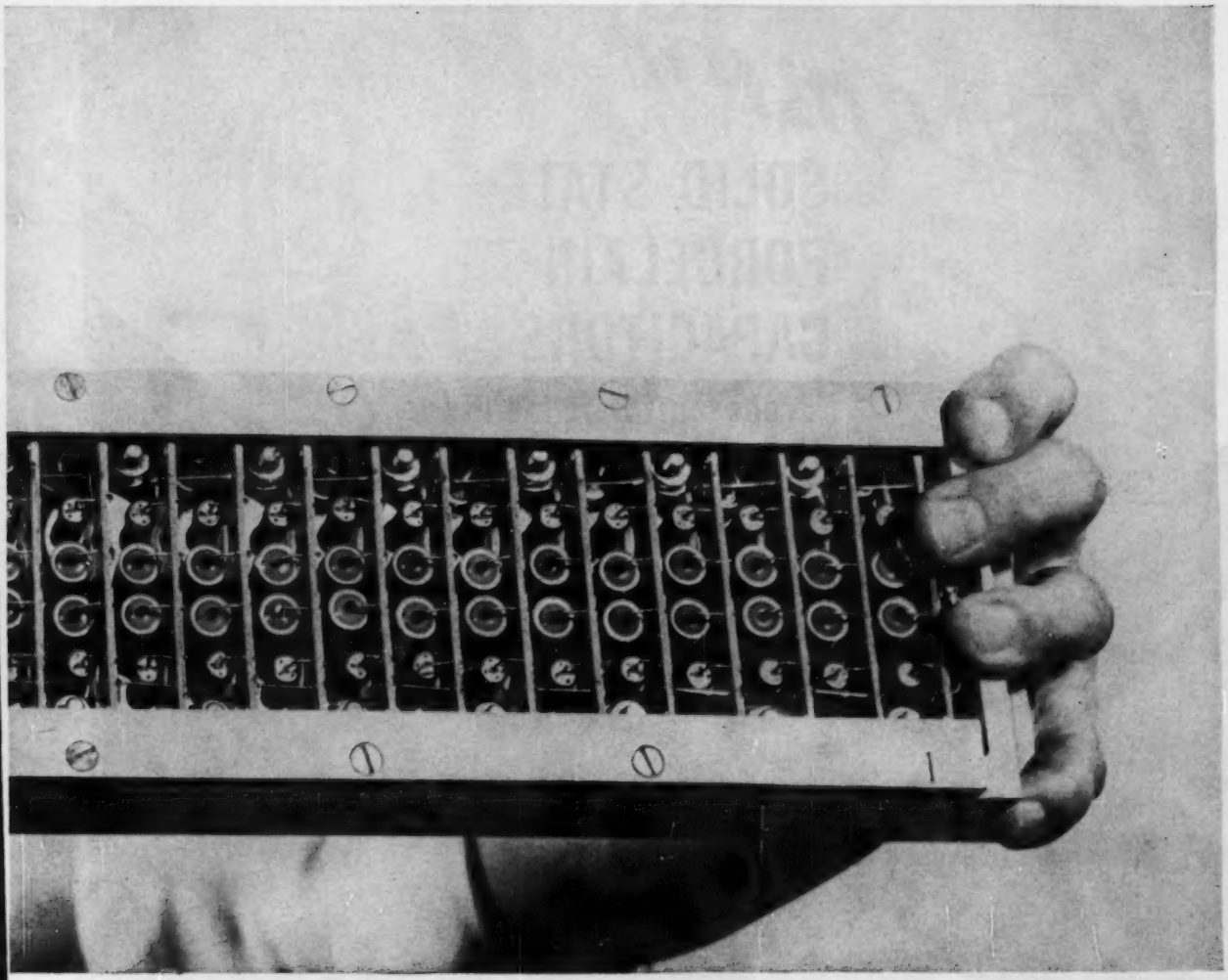

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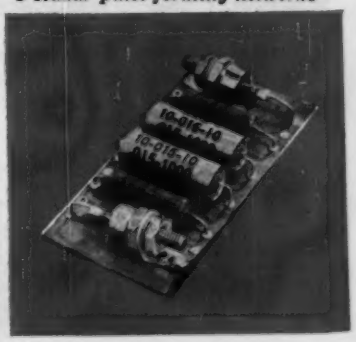

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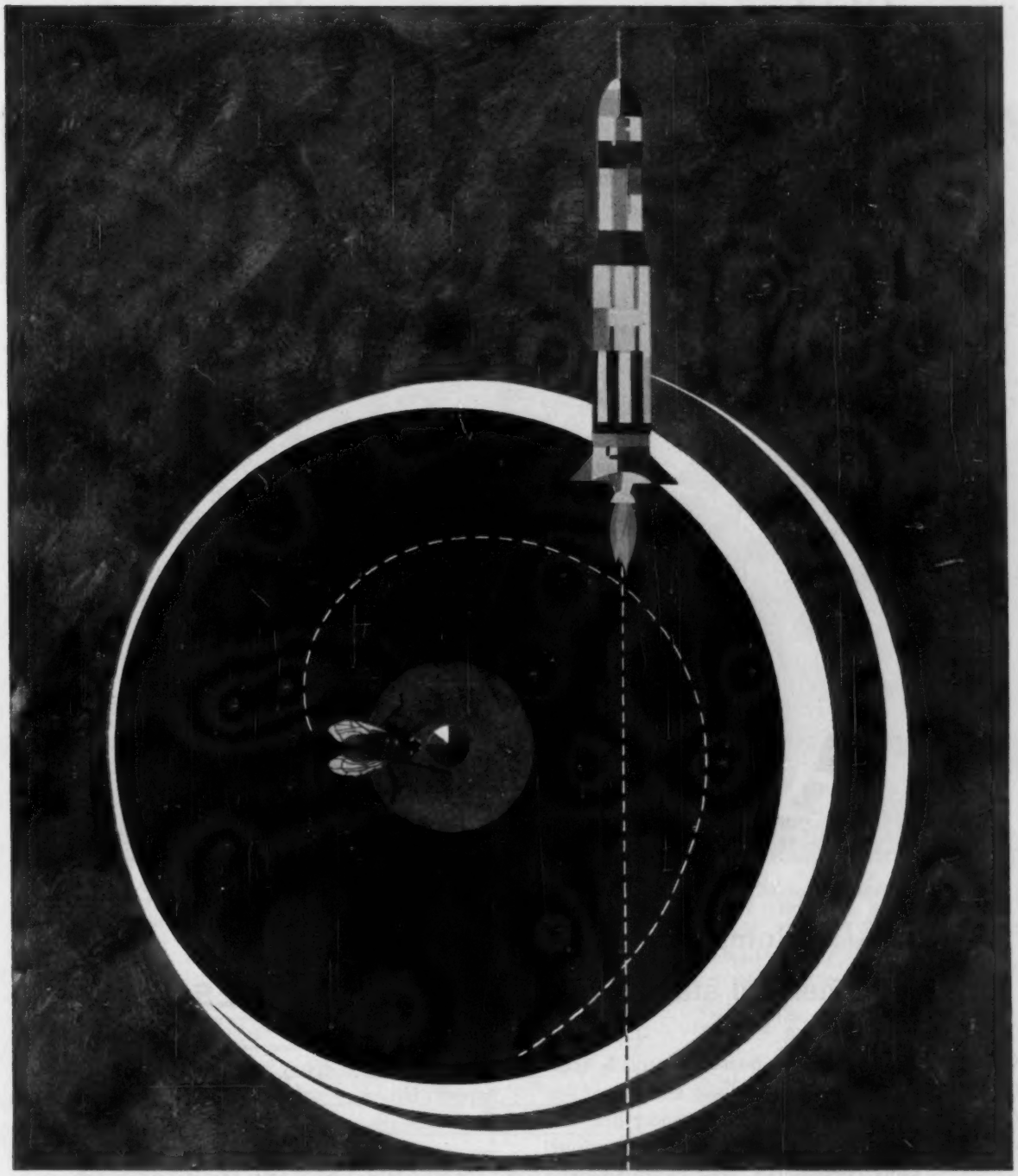

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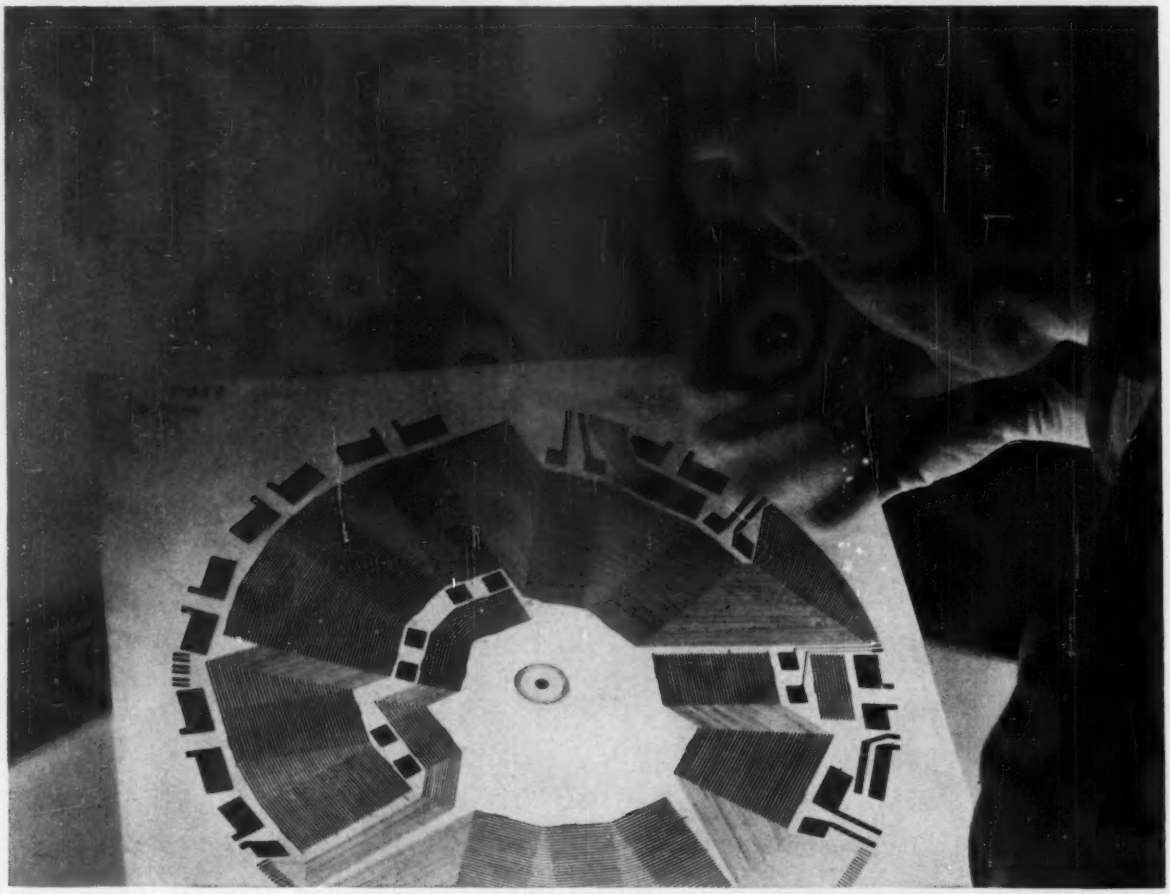

Complex pre-preg boards like this get dimensional stability from **DOW EPOXY RESINS**

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Approx. 5/16" long...

1/8" wide...

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Smaller than a 1-carat diamond!

Mica Capacitor...

Sets New Standard in Miniature Reliability!

This sub-miniature DM-10 Mica Capacitor retains the same superior electrical characteristics of silvered mica capacitors as found in much larger sizes. It assures a high order of performance in extreme miniaturization applications — missiles, printed circuits and all compact electronic equipment. Parallel leads provide greater versatility. Tough phenolic casings protect against physical damage and penetration of moisture.

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Working Voltage	Capacity Range
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Operating Temperature: *up to 150° C.*
Characteristics: *C, D, E and F, depending on capacitance value*
Leads: *#26 AWG (.0159") Copperweld wire*

EL-MENCO'S DM-10 MEETS ALL THE ELECTRICAL REQUIREMENTS OF MILITARY SPEC. #MIL-C-5B AND EIA SPECIFICATION RS-153

Other sizes also ideal for miniaturization applications —
DM-15...up to 820 mmf at 300 VDCW, up to 400 mmf at 500 VDCW.
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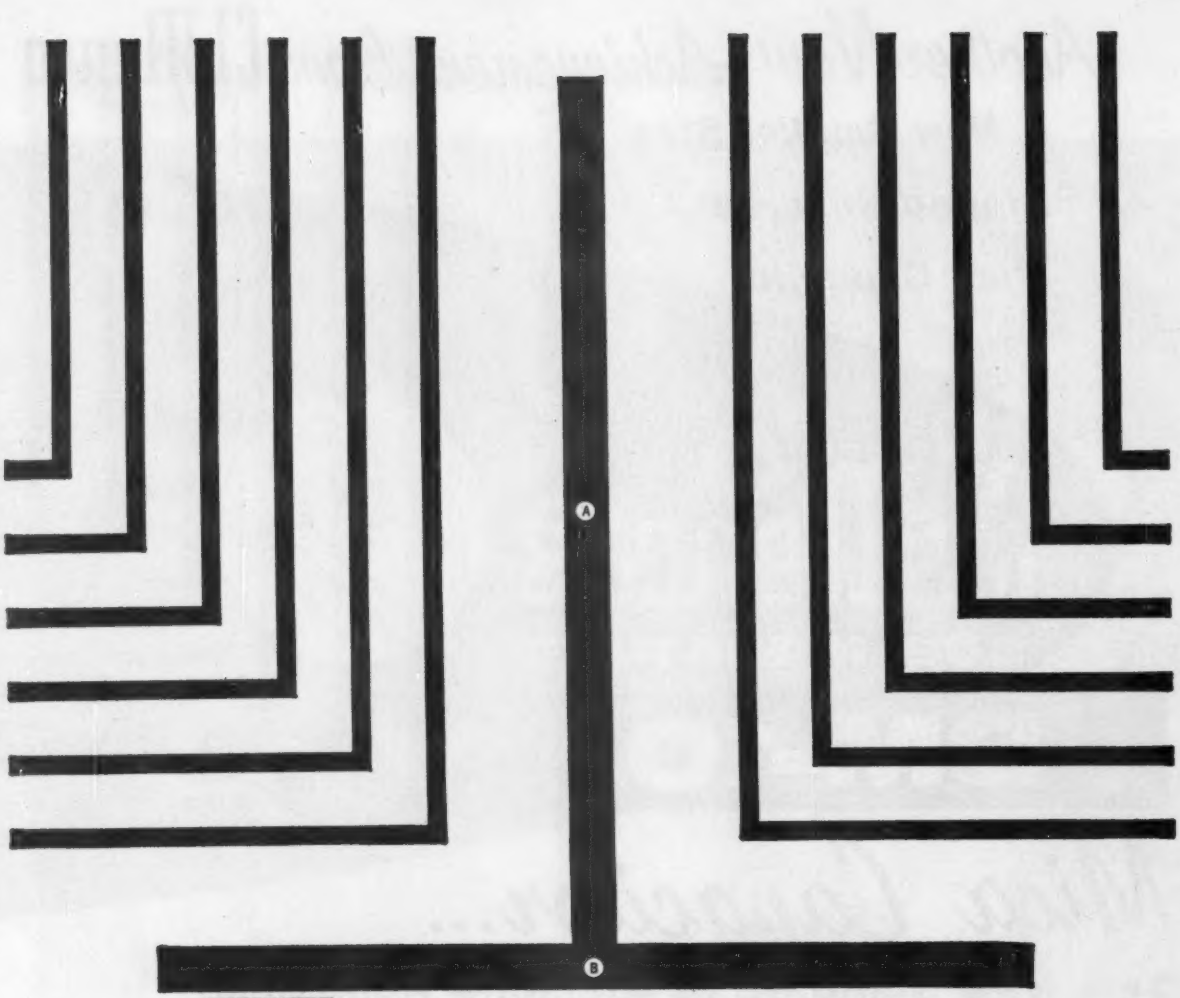
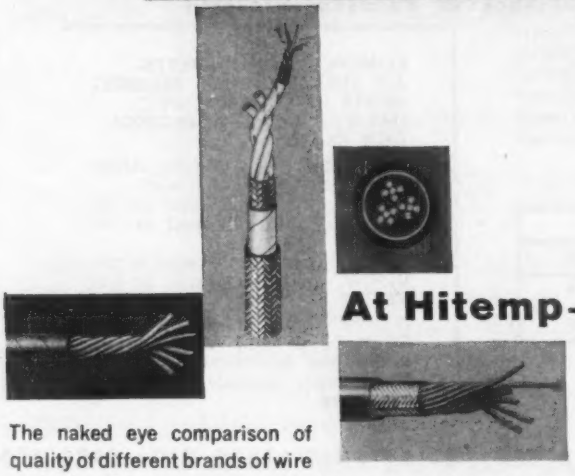


Are lines A and B the same length?



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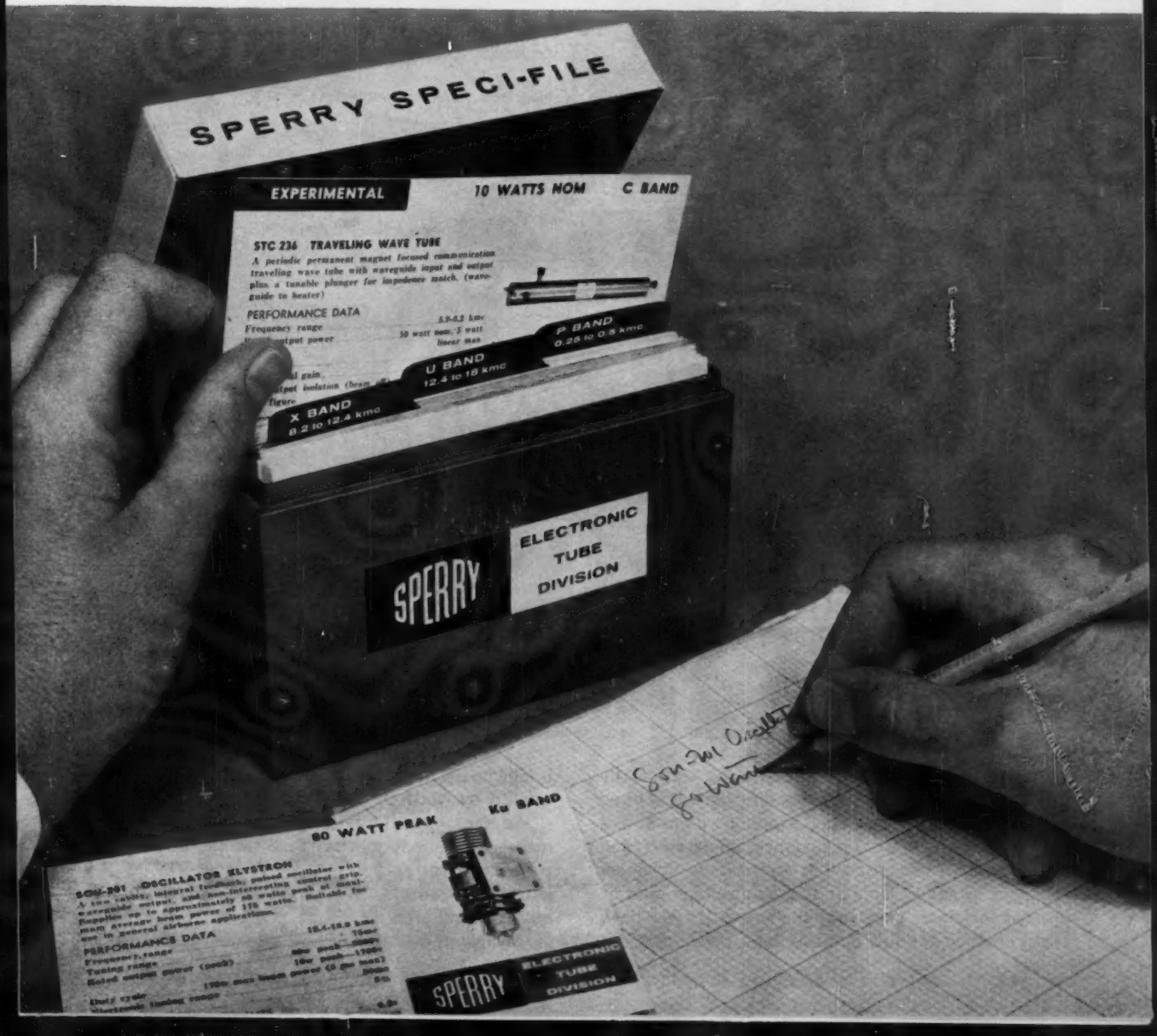

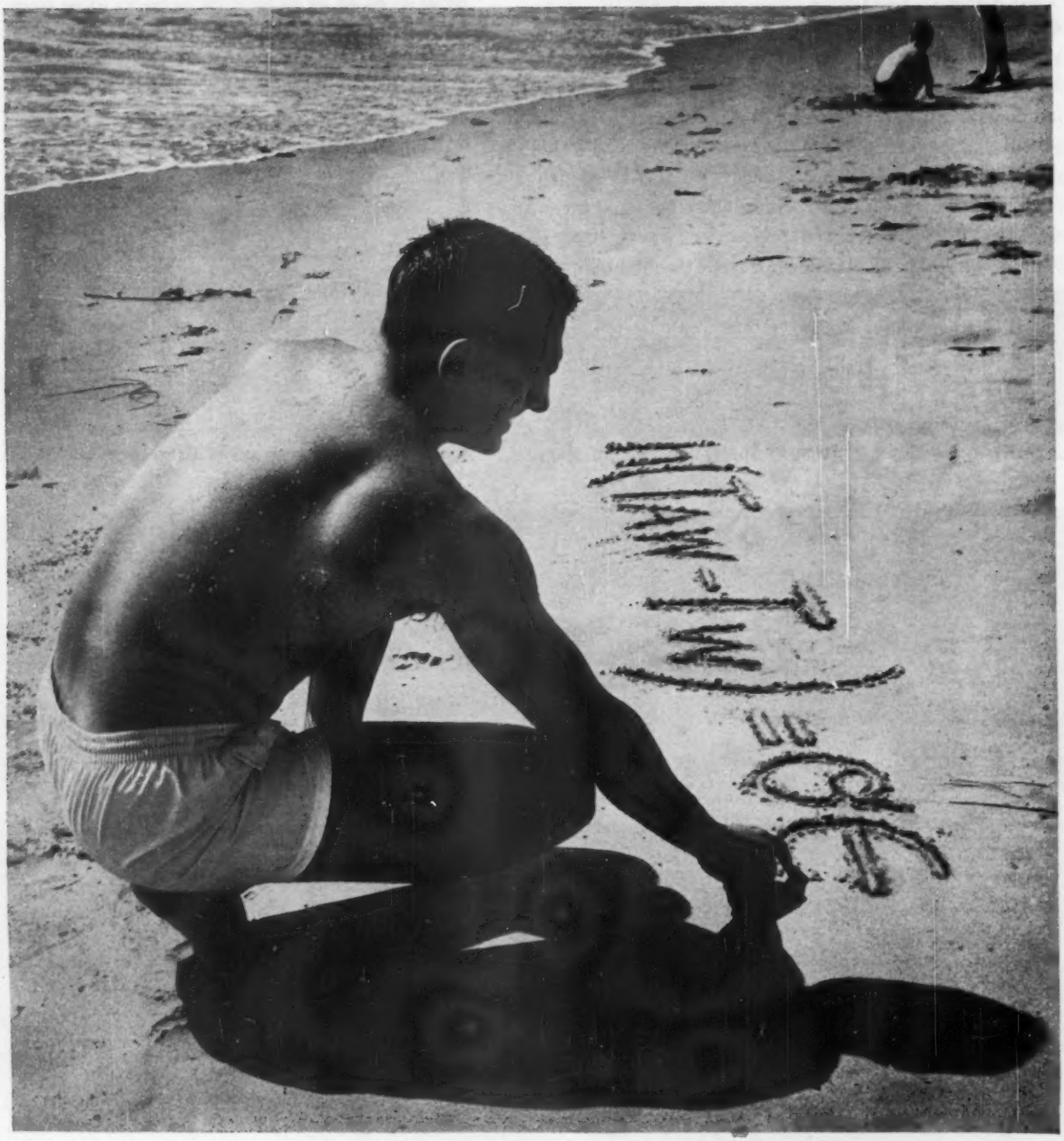

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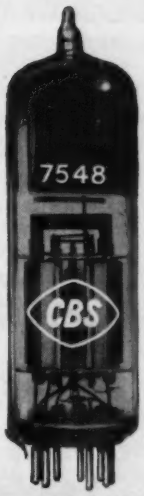
Versatile Secondary-Emission Amplifier



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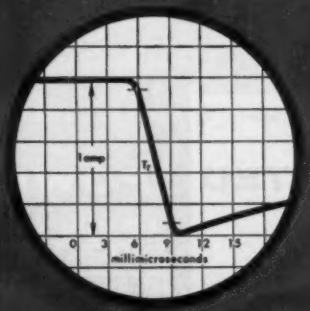

. . . AND WIDE-BAND CLASS A AMPLIFIER

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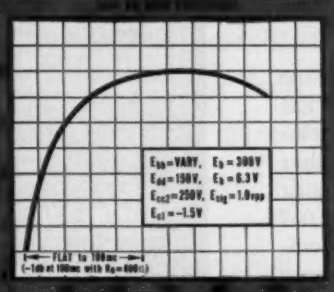
- 3.4 μμf output capacitance



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1. Keen interest in a practical, versatile secondary-emission tube.
2. Its limitless capabilities for simplifying and solving a wide range of circuit problems . . . from fast-rise-time pulse amplifiers and generators to wideband distributed amplifiers.

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AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.1% or 0.2 volts over entire input range (whichever is greater)		
Regulation (load)	Better than 0.1% or 0.2 volts for no-load to full load (whichever is greater)		
Transient Response	Output remains within regulation limits for step-function change of ±10 volts in 105-125 volt input range Output remains within regulation limits for changes from no-load to full-load or full-load to no-load		

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DC Output Range	0-36 volts 0-5 amps	0-36 volts 0-15 amps	0-36 volts 0-30 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.025% or 3 mv over input range (whichever is greater)		
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By THEODORE A. BICKART, RICHARD P. DOOLEY,
The Johns Hopkins University Radiation Laboratory, Baltimore, Md.

THE MEMORY CELLS of an analog computer are circuits that retain information about the level of a signal at some discrete point in time. Due to their functioning, the circuits are often called level-holding circuits. This article describes a simple circuit that holds both negative- and positive-polarity signal levels.

The level-holding circuit is shown in Fig. 1A. The electronic switch is normaly set to connect the output of the switch to the *No.* 2 input of the switch; that is, e_{OUT} is normally equal to e''. The output of the differentiator, e', is e' = a (de_{out}/dt).

The output of the amplifier, e'', is $e'' = -Ae'$. When the electronic switch is in its normal position, the feedback loop is closed and e_{OUT} = e''). The circuit differential equation is $e_{OUT} = -aA\,(de_{OUT}/dt)$. If $e_{OUT}(0) = E$, the solution of the differential equation is

$$e_{OUT}\,(t) = E\,e^{-t/aA} \qquad (1)$$

If E is the signal level, then e_{OUT} will differ from E by an insignificant amount if the time constant aA is large compared to the time for which E must be held. The amplifier in the closed loop makes it possible to obtain a large time constant, aA. The length of time T_h, that signal e_{OUT} will remain within

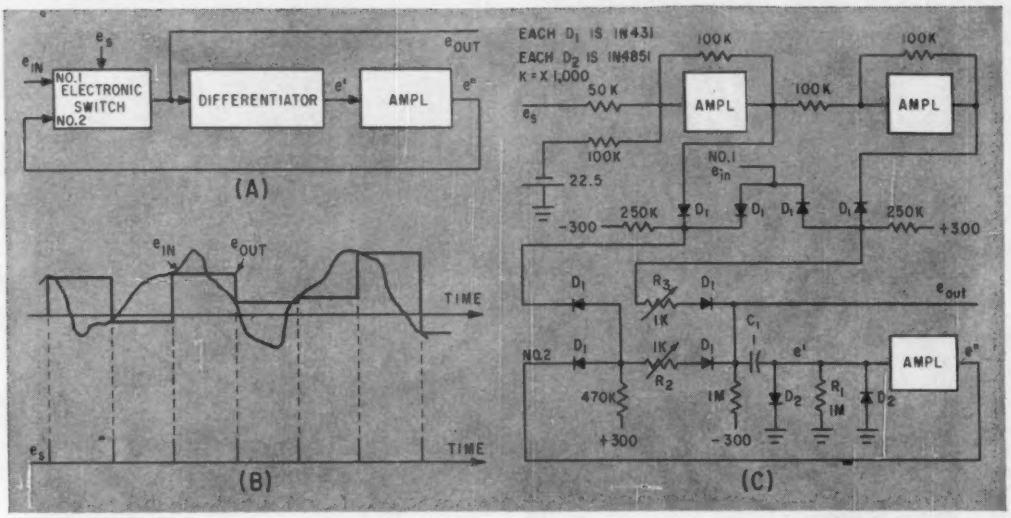

FIG. 1—Level-holding memory cell (A). With each e_s pulse, an e_{OUT} sample of e_{IN} is taken (B). The circuit drawing of the memory cell is shown in (C).

p percent of level E is found from Eq. 1, $T_h = -aA \ln (1 - p)$. For a small p, that is $p, << 1$ $T_h \approx paA$.

When a switching signal is applied at switching-input terminal e_s, the output terminal of the electronic switch is connected to the No. 1 input terminal of the switch. Thus, at the time of application of the switching signal, e_{OUT} is set equal to e_{IN}. When e_s is removed, the e_{OUT} terminal is disconnected from the e_{IN} terminal and connected to terminal e''. Output signal e_{OUT} then holds the level of the input signal e_{IN} at the value it had at the time of the switching signal.

Operation of the circuit is illustrated in Fig. 1B. The switching signal (e_s) is a train of equally spaced pulses, and the input signal e_{IN} is a random signal. The spacing between the switching pulses is short compared to the time constant of the closed-loop circuit. Consequently, the output signal decays by only an insignificant amount in the interval of time between the switching pulses.

Figure 1C shows the complete circuit. The e'' amplifier is an operational amplifier and the electronic switch is a diode-type switch[1] that uses operational-amplifier inverters to deliver the switching signal to points in the diode switch. During the holding time (e_s being zero and the feedback loop being closed), voltage e' is so small that the D_2 diodes are back biased. Consequently, constant a is equal to

$$C_1 R_1 (R_{b2}/2)/[R_1 + (R_{b2}/2)]$$

where R_{b2} is the back resistance of the D_2 diodes. Holding time T_h is therefore

$$T_h \approx C_1 pA R_1 (R_{b2}/2)/[R_1 + (R_{b2}/2)] \quad (2)$$

When the switching signal e_s, which must be an approximately 22.5 positive pulse, is applied, output signal e_{OUT} is disconnected from signal e'' at the No. 2 input to the switch; that is, the feedback loop opens. The output signal is now connected through the switch to input signal e_{IN}, and capacitor C_1 begins to charge. The output voltage approaches the level of the input signal, while the differentiator output voltage, e', is limited at plus or minus several tenths of a volt, depending upon which of the two D_2 diodes becomes forward biased at this time. To charge C_1 in a short time would require that the input-voltage source deliver a current in the order of milliamperes through the switch. However, the switch is a current-limiting device. When the output of the switch is connected to the No. 1 input of the switch, the maximum current that can leave the output of the switch is 900 μa and the maximum current that can enter the output of the switch is 300μa. Thus, C_1 is charged by a constant current of 900 or $-300\mu a$ depending upon whether e_{OUT} is increasing or decreasing. When e_{OUT} comes to within several millivolts of e_{IN} the switch no longer acts as a constant-current-source to C_1, and e_{OUT} exponentially approaches e_{IN}. It is usually satisfactory to assume that C_1 is fully charged when the charging ceases to be from a constant current source; the several-millivolts error entailed is normally negligible. The maximum time required to charge C_1 will be encountered when e_{OUT} must change from its maximum positive value (e^+_{OUT} to its maximum negative value e^-_{OUT}; in this case the charging current will be 300μa. This maximum time, defined as the read-in time, T_r, is

$$T_r = (e^+_{OUT} - e^-_{OUT})\, C \,/300 \times 10^{-6} \text{ sec}$$

C being in farads and $e+_{OUT}$ and e^-_{OUT} in volts.

The switch limits the output voltage to a value less than +22v and greater than −22 v. Thus $e^+_{OUT} - e^-_{OUT} = 44$ v and $T_r \approx 150\ C \times 10^3$ sec. For proper circuit operation e_{IN} must also be limited to this voltage range.

The significance of T_r is that the switching pulse must have a width at least as great as T_r if the output-voltage level is to reach the input-voltage level (the level to be held) under all signal conditions.

The circuit is adjusted and put into operation as follows: Disconnect the output of the amplifier from the No. 2 input and ground the No. 2 input of the switch; adjust resistor R_2 to set e_{OUT} equal to zero. Reconnect the output of the amplifier to the No. 2 input and adjust the amplifier zero control (not shown in Fig. 1C to make e_{OUT} equal zero. Now apply +22.5 v to the e_s input and reduce the input signal (e_{IN}) amplitude to zero. Adjust resistor R_2 to set e_{OUT} equal to zero; for this adjustment to be possible the input-signal source impedance must be less than 500 ohms (this is a requirement of the diode switch). Then remove the d-c potential from the e_s input.

Figure 2A shows e_{OUT} during the read-in time as C_1 is charged linearly from −10 v to +10 v. Note that time increases from right to left on the horizontal axis. The 22.5-v, 150 m sec switching pulse e_s is superimposed upon the trace of e_{OUT}. Since C_1 is charged by the 900 μa source, the output voltage takes 22 m sec to change by 20 volts.

Figure 2B shows the output voltage as it decays from +10 v. The photograph indicates that the output voltage has decayed by 10 mv (0.1 percent) in approximately 11 seconds. The operational amplifier had a gain of 15×10^3 and the D_2 silicon diodes had back resistances of approximately 30×10^3 megohms; consequently, Eq. 2 indicates that the output voltage should take approximately 15 seconds to decay by 0.1 percent. The agreement between the measured and calculated values of the time for e_{OUT} to decay by 0.1 percent is satisfactory since an error current, due to improper amplifier balancing, of as small as 10^{-9} ampere will result in a 10-mv error in the value of e_{OUT} in 10 seconds. The circuit has also been tested with $R_1 = \infty$. With $R_1 = \infty$, levels have been held to within ten percent for from 10 minutes to an hour. The calculated value of T_h is about 10^4 hours. Thus, imperfect balancing of the amplifier is the limiting factor in achieving extremely long holding times.

Figure 2C shows a 20-v peak-to-peak, 0.075-cps sine wave superimposed upon the held samples of that sine wave. The sample (switching) pulses occur every 1.1 seconds. This photograph shows the level-holding capabilities of the circuit for a number of different input-signal levels at various switching-pulse times.

The circuit has an inherent, absolute error of plus or minus several tenths of a volt. This error is due to the forward bias potential of the D_2 diodes. The nonlinear resistance created by the D_2 diodes in parallel with resistor R_1 has the approximate voltage-current characteristic shown in Fig. 3A. The absolute error is approximately equal to voltage e_b; with silicon diodes, e_b will vary from about three to seven tenths of a volt. If e_b can be made smaller, then the absolute error inherent in the circuit can be reduced; however, e_b should not be reduced at the cost of a smaller slope to the voltage-current characteristic at the origin. Experimental observations of the drift of the circuit away for balance show that a slope of one megohm is about as small a slope as one would want. The absolute error may be observed in Fig. 2A as the slight drop in e_{OUT} at the end of the switching pulse and in Fig. 2C as the slight separation of the sine-wave input signal and the beginning of each held portion of the output signal.

If in an application of the level-holding circuit it becomes necessary to reduce the absolute error as much as possible, the circuit modification shown in Fig. 3B may be introduced. The two potentiometers may be adjusted to reduce the value of e_b. This circuit modification has made it possible to reduce the absolute error to about 0.15 v.

Theoretical analysis and experimental data show that this two-polarity level-holding circuit will be very satisfactory.

This research was supported by the United States Air Force through WWRNGW of the Wright Air Development Division of the Air Research and Development Command.

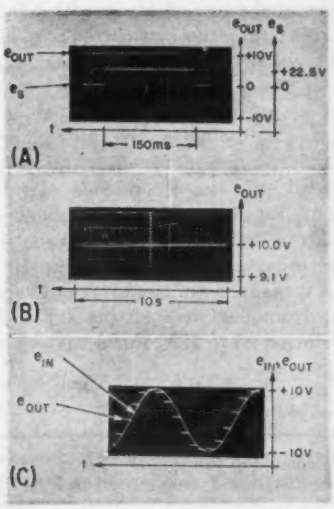

FIG. 2—In (A), e_{OUT} goes from −10 to +10 v during read-in time. In (B), e_{OUT} shows slight decrease in 10 sec. Horizontal streaks imposed on sine wave in (C) are samples of sine-wave levels

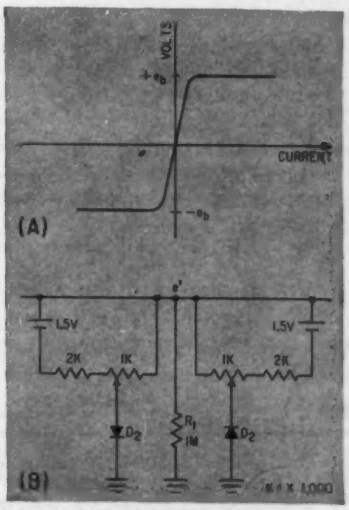

FIG. 3—Voltage-current characteristic of D_2 diodes in parallel with resistor R_1 (A). Schematic (B) is circuit modification for reducing absolute error due to voltage drops across diodes

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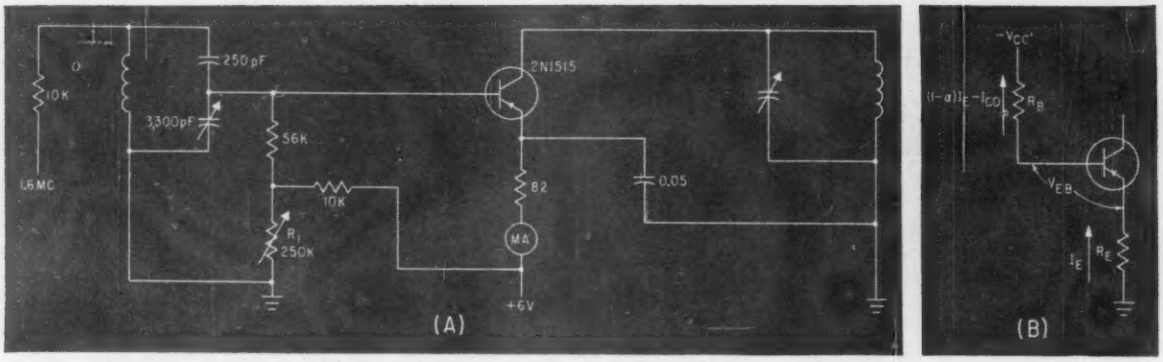

FIG. 1—Transistor test circuit (A) and the Thevenin equivalent of its biasing arrangement (B)

BIASING TRANSISTORS

Conditions for uniform gain despite variations in transistor beta values are derived from Thevenin equivalents of the transistor biasing arrangements. Circuits based on results are tolerant of variation in transistor beta values

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TO OBTAIN uniform gain in transistor circuits, it is important to maintain uniform emitter current despite spreads in the d-c beta values of transistors. A Thevenin's equivalent of a transistor bias network is analyzed to determine conditions for uniform emitter current, and the resulting theoretical results are verified experimentally.

Practical effects of a change in emitter current on power gain was examined by measurements on ten 2N1515 transistors at emitter currents of 1 ma and 1.5 ma.

Figure 1A test circuit measures power gain, with emitter current manually varied by bias potentiometer R_1 in the base circuit. Total emitter resistance including the resistance of the milliammeter is 120 ohms. The equivalent parallel resistance of the capacitive tap on the input tank is 146 ohms, while the equivalent parallel resistance of the output tank is 5,440 ohms.

A simple bias network contains a single resistor connected between the base and the collector supply. More elaborate voltage divider bias networks can be reduced to this single resistor and a supply voltage form by Thevenin's theorem. Therefore, the only circuit that need be analyzed is that shown in Fig. 1B.

The equation for the bias network becomes

$$I_E R_E + (1-\alpha) I_E R_B - I_{CO} R_B = V_{CC}' - V_{EB} \quad (1)$$

$$I_E = \frac{V_{CC}' - V_{EB} + I_{CO} R_B}{R_E + (1-\alpha) R_B} \quad (2)$$

and since $|V_{CC}'| \gg -V_{EB} + I_{CO} R_B$
and $(1-\alpha) \doteq 1/\beta$
then $I_E \doteq V_{CC}'/(R_E + R_B/\beta)$ (3)

Considering Eq. 3, for uniform emitter current the following inequality must be satisfied

$$R_E \gg R_B/\beta \quad (4)$$

Five transistors with d-c beta's ranging from 26.4 to 183 were placed in a bias network consisting of $R_E = 100$ ohms, $R_B = 0.47$ megohm, $-V_{CC} = 6$ volts, $V_{EB} = 0.25$ volt (taken as a constant) and I_{CO} neglected.

As can be seen from Table I, there is an almost-constant difference between the measured and calculated value of I_E. However, the calculated value of ΔI_E is within 3.3 percent of the measured value. The change in emitter current ΔI_E is the most important parameter as far as uniformity is concerned because it indicates the spread in emitter current for a particular spread in beta. From this standpoint, Eq. 3 provides excellent correlation with the measured data. For a ratio of $R_E/R_B = 0.2 \times 10^{-3}$ the measured emitter current varied from 0.28 to 2.00 ma for a β variation 26 to 183. For a variation

TABLE I — Comparison of Calculated and Measured Circuit Parameters

β	Measured I_E (ma)	Measured ΔI_E from previous transistor	Calculated I_E (ma)	Calculated ΔI_E	Percent Diff in ΔI_E
26.4	0.28	....	0.32	....	....
46.4	0.52	0.24	0.56	.24	0
103[a]	1.10	0.68	1.23	.67	1.47
183	2.00	0.90	2.16	0.93	3.3

(a) Two transistors had the same value of beta

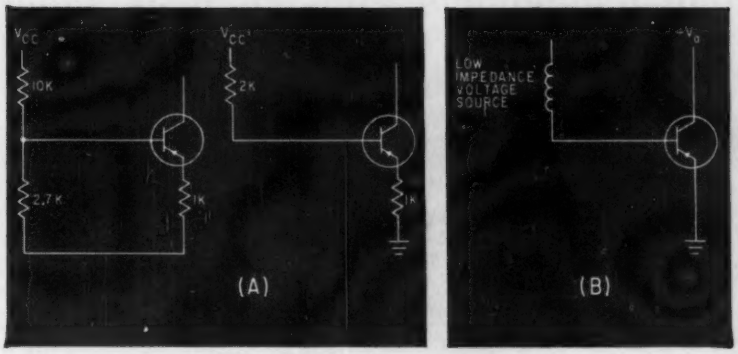

FIG. 2—Diagram (A) shows a transistor with a voltage divider bias supply together with a Thevenin equivalent of this bias circuit. Diagram (B) shows a biasing arrangement where emitter resistors are undesirable

Table II — Variation in Emitter Current for Various β Values

β(DC)	Measured I_E (ma)	
	Fig 2A Circuit	Fig 2B Circuit[a]
132	1.00	1.08
119	0.98	1.03
86	0.96	1.00
40	0.93	1.01
32	0.90	1.00

(a) Voltage V_{BE} adjusted to give 1 ma at $\beta = 32$ and held at same value throughout test

FOR UNIFORM GAIN

in β of 46 to 183 the emitter current varied from 0.52 ma to 2.00 ma.

The utility of transistors with emitter current variation given in the above example will depend on the application and performance desired. Normally the emitter current variation given is unacceptable from the viewpoint of uniformity or gain and stability considerations. Where greater uniformity is desired, circuits with better stability must be recommended.

A circuit with bias provided by a divider of 10,000 ohms and 2,700 ohms, with an emitter resistor of 1,000 ohms can be converted to an equivalent Thevenin's circuit with a series resistance of approximately 2,000 ohms and an emitter resistor of 1,000 ohms as shown in Fig. 2A.

Necessarily, V_{cc} is different from V_{cc}' because of the Thevenin conversion, but as far as the spread in emitter current is concerned there is no change in Eq. 3.

If the β spread is taken as 32 to 132 (for example), the spread in the emitter current can be calculated as

$$\Delta I_E = V_{CC}/(R_E + R_B/\beta_1) - V_{CC}/(R_E + R_B/\beta_2) \quad (5)$$

With a nominal V_{cc} of 6 volts the voltage in the Thevenin's equivalent will be approximately 1 volt, therefore

$$\begin{aligned}\Delta I_E &= 1/[1{,}000 + (2{,}000/32)] \\ &\quad - 1/[1{,}000 + (2{,}000/132)] \\ &= 10^{-3}\,[0.941 - 0.985] \\ &= 0.04 \text{ milliamp}\end{aligned}$$

This amounts to a change of 4 percent of emitter current for a change of 400 percent in β.

For an emitter resistor of 1,000 ohms and a series base resistance of 2,200 ohms the results shown in Table II were obtained. Betas of 32 to 132 were used.

For a 400-percent change in beta, a 10-percent change in emitter current resulted. The difference between the theoretical spread of 4 percent can be accounted for by the approximations made in Eq. 2.

In circuits that have their gain varied by an agc system, large emitter resistors cannot be used as they counteract the agc effect. A semiconductor diode agc supply may have a series resistance of 5,000 ohms and a dynamic impedance of 30,000 ohms. Uniform emitter current in such a circuit would be difficult to obtain without serious limitations in the permissible β spread.

This difficulty can be overcome by voltage feeding the base as is indicated in Fig. 2B.

For a 400-percent change in β, an 8-percent change in I_E results. The spread in emitter current is less than the spread obtained in the recommended circuit.

To obtain a low-impedance voltage agc source, audio stages can be used as both audio amplifiers and as d-c amplifiers. The output of such a d-c amplifier can be as low as 100 ohms. To prevent the agc circuit from shunting the r-f signal, it is necessary to place a choke in series with this line.

Unless $R_s >> R_E/\beta$, both high and low β limits are required to obtain uniform emitter current. Normal r-f stages that have agc require β limits or some other method of obtaining uniform emitter current because of their low value of emitter resistor. Voltage fed r-f stages exhibit small spreads in emitter current and thereby offer a solution to the emitter current stability problem in r-f stages which have agc.

Stages other than the r-f can be stabilized for emitter current by satisfying the inequality $R_s >> R_E/\beta$. Typical values for good emitter current uniformity are R_s = 2,000 ohms, R_E = 1,000 ohms. This type of stage can also have agc through use of a diode damping system.

It becomes apparent from the inequality $R_s >> R_E/\beta$ that the higher the average β (as long as there is some value of R_E) the greater the current stability and power gain stability. As most stages, including agc stages, incorporate at least 100 to 200 ohms of R_E for thermal stability, transistors with a high average and high minimum β have a decided advantage over low β transistors. A post-alloy diffused transistor PADT 24 with a minimum β of 40 and an average β of 150 is an example satisfying the requirement for high β. When the minimum and average β are high enough, the maximum β need not be specified.

All-electronic device permits taking a series of still photographs of high-speed phenomena at 2 μsec intervals

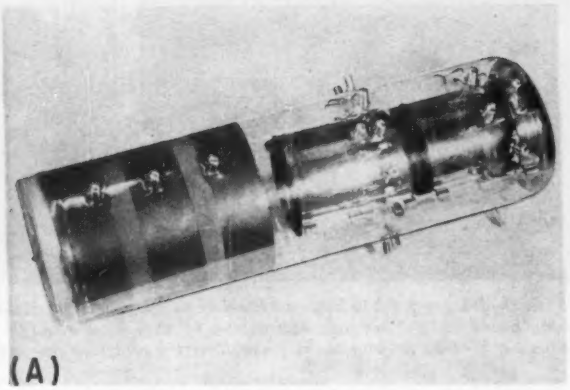

FIG. 1—Image converter tube (A) is electrically arranged

Image Converter Tube

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CONVENTIONAL HIGH-SPEED photography is limited in speed by the sensitivity of the photographic film and the precision and speed of mechanical elements. Kerr cells have been used to increase shutter speed, but even this system is limited by the sensitivity of photographic film.

Several types of all-electronic high-speed cameras using image converters have been developed in the United States and Britain[1, 2, 3, 4, 5]. This high-speed camera is based on a U. S. image converter and uses shutter pulses with a width of 0.1 μsec at a repetition rate of one pulse every 2 μsec.

Basic operation of the image converter is as follows. An optical image of the object to be photographed is focussed on the photocathode of the image converter tube.

The electrons emitted from the photocathode are focussed by suitable electron optics on the fluorescent screen. A camera is used to photograph images appearing on this screen.

Under these conditions, a single image will appear on the fluorescent screen at any moment. Thus only one picture can be taken.

If a set of deflection plates, arranged in the same fashion as the deflection plates of a conventional cathode-ray tube were inserted between the photocathode and the fluorescent screen, then the electron beam can be deflected to any desired place on the fluorescent screen.

This would produce only one picture at some desired place on the screen. However, if a series of deflection plate pairs were arranged around the electron beam, and the electron beam could be gated on and off, then it becomes possible to synchronize beam gating and deflection so that a series of images, occurring short periods of time apart, could be displayed on the fluorescent screen.

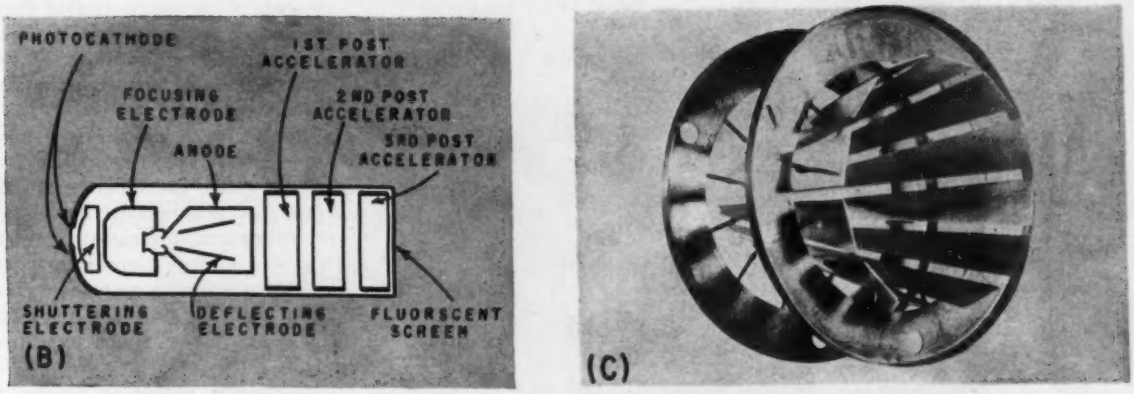
The image converter tube is shown in Fig. 1. The photocathode surface consists of a segment of SbCs semitransparent film with a useful diameter of 35 mm. Aluminum is deposited on the fringe of the screen to prevent leakage of external light into the tube. The screen is also metalized to improve light efficiency and prevent light from scattering back to the photocathode. A three-stage post accelerator is placed between the tube anode and fluorescent screen. The d-c voltage on the anode and deflection system is approximately 3,000 v with the post accelerators and fluorescent screen at approximately 6,000 v.

The first grid, called the shutter electrode, uses voltage pulses to control the flow of photoelectrons from the photocathode. The deflection system consists of six pairs of planar electrodes arranged within the anode as a conical envelope. Six-phase sinusoidal voltage is applied to the six pairs of electrodes resulting in a rotating deflection field; Fig. 2 shows this field at one instant. When the polyphase voltage is applied to the six pairs of electrodes in succession, the position of the image on the screen will be displaced around a circle. Gating the shutter electrode with 12 pulses will generate 12 images as shown in Fig. 3.

In an ordinary cathode-ray tube where a sharp pencil beam of electrons is to be deflected, two pairs of planar deflection electrodes (horizontal and vertical) are used.

In this image converter, appreciable image distortion results if conventional deflection is used. To overcome this difficulty, six pairs of deflection electrodes are used.

The rotation frequency of the beam is limited by the electron tran-



as shown in (B). Deflection-plate arrangement shown in (C) contains six pairs of electrodes

For High-Speed Photography

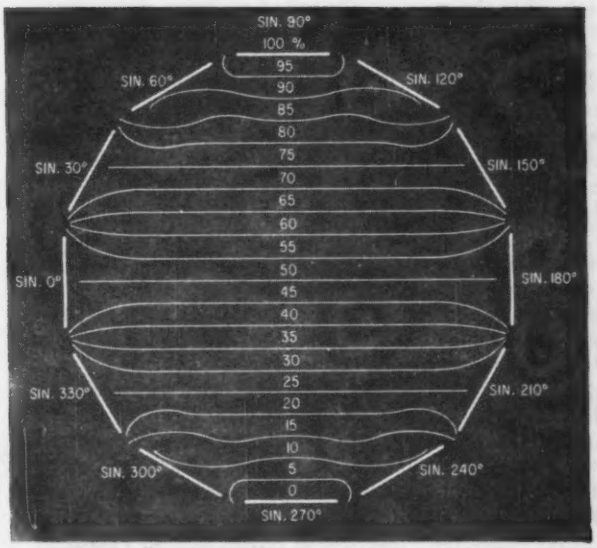


FIG. 2—Potential distribution of deflection field

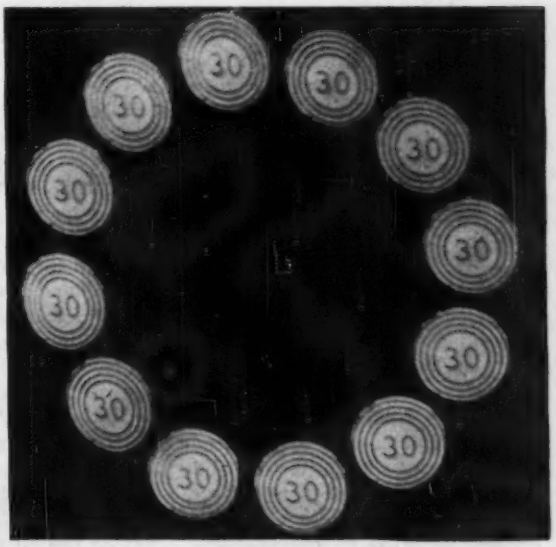


FIG. 3—Example of 12 framed images

sit time under the deflection electrodes.

The theoretical maximum rotation frequency of the image converter tube used in these tests is approximately 33 Mc.

To produce a rotating field, a six-phase generator is required. Since the deflection sensitivity of the present tube is approximately 100 v per cm (Table I), a source of several hundred volts is required. To complete a rotational deflection in 20 μs, 50 Kc 6-phase alternating voltage is required. The output of a 50-Kc oscillator is fed to a group of phase shifters to produce components of a six-phase voltage.

Normally, the shuttering electrode is biased negatively beyond cutoff and when a positive-going pulse is applied, the electrode permits photoelectrons to reach the fluorescent screen. Combined with the rotating deflection field, gating the shutter electrode produces a circular deflection of the photocathode image on the fluorescent screen.

A voltage swing of approximately 150 v is required for the shutter voltage to cut off the image from the condition of perfect focus. As the image can distort at lower volt-

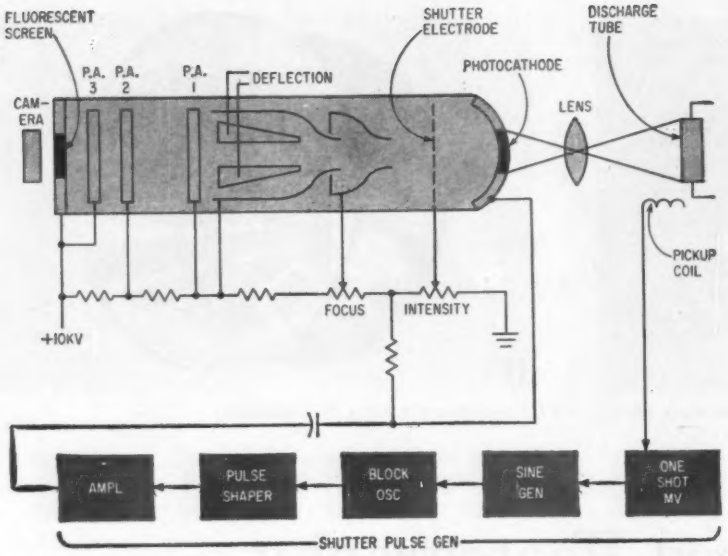


FIG. 4—Image converter setup to make a series of still photos of a plasma discharge tube during firing

ages, rapid switching and a short rise and decay times are required of the shutter pulse. The tube operates with a pulse width of 0.1 μsec, rise time of 0.01 μsec and repetition rate of 1 pulse every 2 μsec.

The shutter pulse generator (Fig. 4) accepts a trigger pulse and converts it into a square wave. A sinusoidal oscillator is controlled by this square wave so that it generates the desired number of shutter pulses during the square wave.

The sinusoidal oscillator triggers a blocking oscillator that generates a sharp high-amplitude spike for each triggering sine wave. These signals are further amplified in a distributed amplifier and the output is used to gate the shutter electrode of the image converter.

A typical use is shown in the plasma discharge photography system shown in Fig. 4. The circular-sweep deflection system of the image converter is normally operating and the photocathode is cutoff. When the plasma discharge starts, the shutter pulse generator is triggered by a pickup coil near the discharge tube. The shutter pulse generator then sends a predetermined number of pulses—10 in this application—to the photocathode of the image converter.

Thus, a predetermined number of images are displayed circularly on the fluorescent screen of the image converter, each displaced in time by a small amount. The first image of the series can be readily identified as there is a longer time gap between the last image and the first image of the series. The time gap between images can be varied by adjusting shutter-electrode repetition speed and deflection-plate sweep speed.

In recent times, image converters have found many new applications. Besides uses as snooperscopes and light amplifiers, they have been used widely in the field of ultra high speed photography.

In this latter field, the tubes have been mainly magnetic focus image converters and the image was pulsed on and off the screen by pulsing the total accelerating voltage on and off the image converter.

PERFORMANCE CHARACTERISTICS

Third P. A.[a]	9,000	6,000	V
Second P. A	6,000	4,500	V
First P. A	3,000	3,000	V
Anode Voltage	3,000	3,000	V
Focus Electrode	520	500	V
Shutter Electrode			
Operating Voltage	66	62	V
Cut-Off Voltage	−17	−15	V
Deflection Factor	100	80	V/cm
Magnification Factor	1.3	1.5	Times

(a) P. A. is post accelerator

Recent work on controlled thermonuclear reactions has necessitated detailed observations of the hot gaseous phenomena using extremely small exposure times.

The Kerr cell shutter was used for a considerable period but this suffered from the inherent disadvantage of poor sensitivity in the spectral region of greatest interest. This is a serious limitation when used for gas discharge work owing to the small light output available at an extremely small exposure time.

The image converter allows a high efficiency output and if demagnification of the image is permissible, then a considerable brightness gain may be obtained since the screen brightness is proportional to the inverse square of the image magnification.

Image converters have also found widespread use in rendering infrared images visible to the eye and as X-ray image intensifiers.

The use of an image converter as a high speed photographic shutter arises from the fact that the electron beam, constituting the intermediate electron image, may be easily controlled and that such control involves extremely small inertia.

Experimental photography using strobe lamps has been tried with the image converter tube system. In this case, the trigger pulse was obtained by the voltage drop across a small resistor inserted in series with the strobe lamp.

It is expected that future developments will include a storage screen with a larger useful screen area and a reduction of exposure time to approximately 0.01 μsec.

The author acknowledges the assistance of S. Matsuda, K. Takeuchi, T. Sasaki, K. Owaki, T. Oshida, S. Shinohara and M. Masuda.

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Automatic relay tester monitors 20 normally closed and 30 normally open contacts in the equipment at left. Toggle switch S_1 is hidden by the clipboard. Reset pushbutton S_2 is at the lower right of the panel

Automatic Relay Tester Detects Intermittents

Up to 30 relays are cycled by the tester, which stops and holds if any contact fails. It lights a lamp to identify the faulty contact

By FRANK TRAINOR, Engineering Dept., Admiral Corp., Chicago, Illinois

MINIATURE hermetically sealed relays designed to meet military specs on shock, vibration and temperature operation may exhibit intermittent contact faults. Either the normally open or the normally closed contacts may fail intermittently and resist all efforts at detection when static tests are used.

A cycling test in which contact circuits are continuously monitored has a double advantage: the intermittent contact is identified, and the contact surfaces are worn in. Often, an intermittent contact fault occurring in the first 100 cycles will heal and not repeat in the next

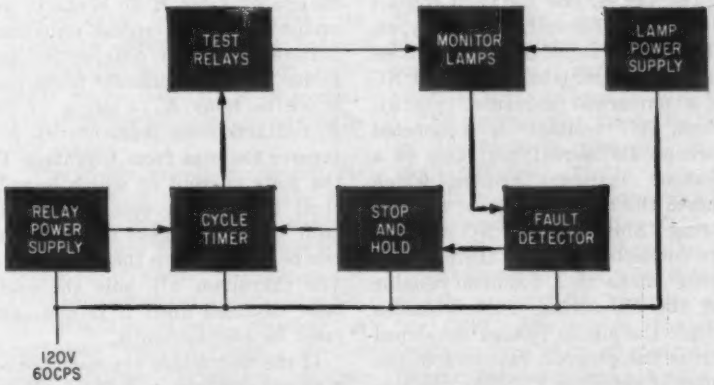

FIG. 1—Block diagram of automatic relay tester. The lamp power supply is not shown in the schematic

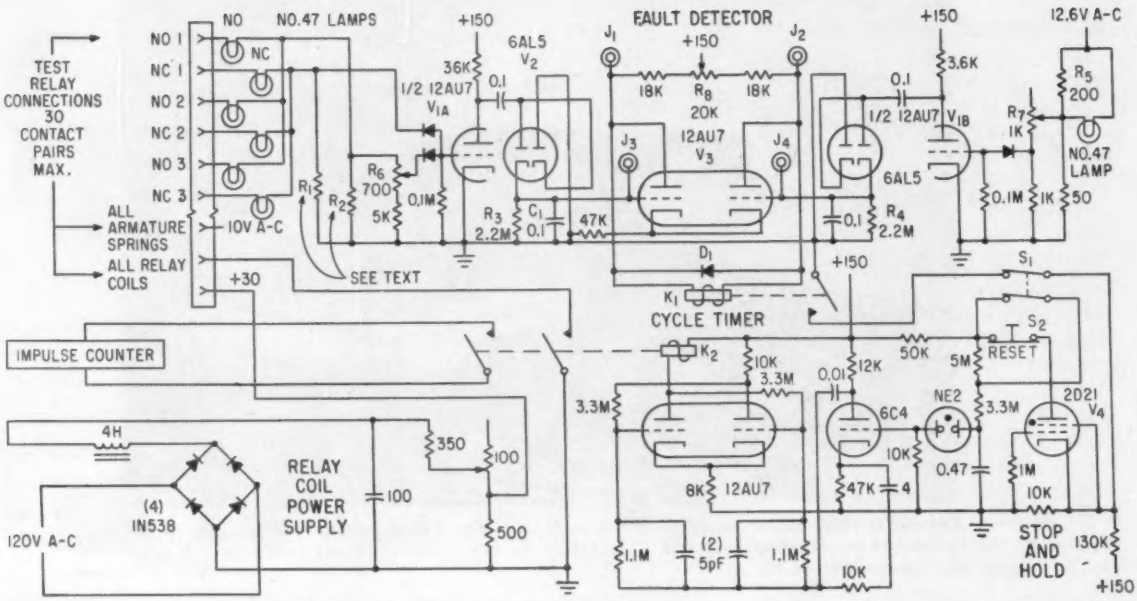

FIG. 2—Schematic of automatic relay tester. Not shown are the four transformers and plate-voltage supply that provide the various circuits with the indicated voltages

ten thousand cycles.

The equipment can monitor as many as 30 NO and 30 NC circuits. It consists (Fig. 1) of a cycle timer that switches all coils on for 0.5 second and then off for 0.5 second, a fault detector and a stop-and-hold circuit that interrupts the timing sequence when a contact fault occurs. The lamp panel identifies the circuit at fault.

The cycle timer (see Fig. 2) is a bistable multivibrator triggered by a relaxation oscillator at the 0.5-second rate. Relay K_2 in the multivibrator plate circuit switches the parallel-connected relay coils of the units under test.

The lamps, one for each contact circuit, are 6.3-volt, 150-ma types. They are arranged on the test panel in two strings, labeled NO and NC in a numerical sequence (photo). Each NO contact is connected through its identifying lamp to a common resistor through which passes the total current of the NO string. Similarly, the NC contacts are connected through their identifying lamps to a common resistor for the NC string. Silicon diodes couple the signal voltage developed across the common resistors to the input of amplifier V_{1A}. The two signal sources are adjusted to equal amplitudes and appear in sequence at the cycling rate.

The peak-to-peak value of V_{1A} output is supplied to one input of differential amplifier V_3 by doubler rectifier V_2. The other differential amplifier input is supplied by a similar rectifier-doubler and amplifier, V_{1B}. A reference signal, obtained from the same 60-cps source which supplies the lamp strings, is applied to the input of V_{1B}.

The output of the differential amplifier is made to null when all test relays are operating normally. A fault by one contact will then drop the total lamp current in that string, which represents a signal change of 1/30, if 30 contacts are under test. This signal unbalance between the two differential amplifier inputs is sufficient to operate sensitive relay K_1. Closing of the K_1 contacts even momentarily will remove the bias from thyratron V_4, the plate current of which is sufficient to stop the relaxation oscillator before the next trigger pulse can be delivered to the cycle timer. The thyratron will hold the oscillator disabled until it is manually reset by pushbutton S_2.

If the test relays are mounted on a shock-isolating pad, the fault information will remain displayed on the lamp panel indefinitely. An external pulse counter may be used to record the number of pulses before fault. The system is thus automatic; it need only be logged and reset at the convenience of the operator.

The sampling resistors in the lamp string, R_1 and R_2, should be derated to 25 percent of their labeled power rating. Also, their temperature coefficient of resistance should be 0.001 percent per deg C. They may be hand-wound with 16-gage Advance wire (Fig. 3). Resistance tolerance of 5 percent is good enough; the higher value unit may be used as R_2. The resistance is found from: $R = 4/NI$, where N is the number of lamps per string and I is the individual lamp current. There is no need to have equal numbers of NC to NO circuits. If the voltages developed across each resistor are equal, null can be achieved regardless of differences between the lamp strings. The smaller lamp string will provide a greater differential signal upon fault.

At the end of each cycle period, the lamp signal voltage falls to zero for a time corresponding to the pull-in time of the relays under test. Also, at the start of each cycling

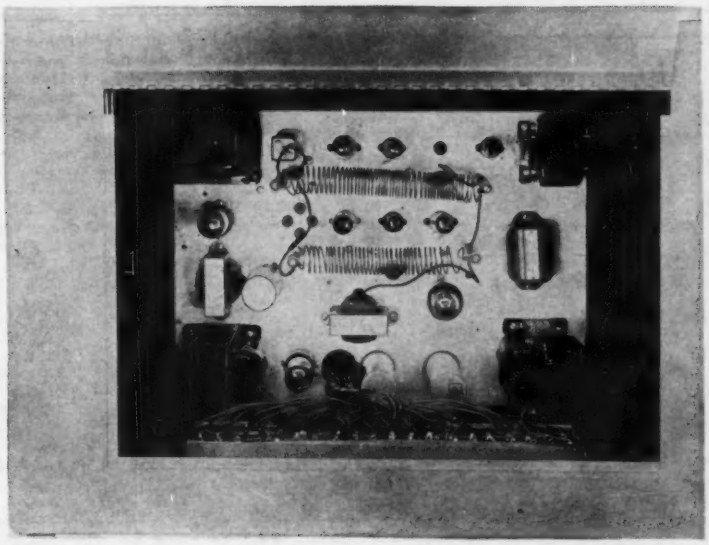

FIG. 3—In a top view of the tester chassis, the suspended coils are R_1 and R_2. Null-adjustment potentiometers R_6, R_7 and R_8 are at the chassis rear

period, the lamp surge current will cause an increased signal spike. The integrated sum of these opposite-going transients is not exactly zero but it is still not enough to operate the fault detector. Typical operate and release times for miniature relays are 0.01 and 0.004 seconds. But these are dependent on the circuit used, as both electrical and mechanical inertia are involved. The electrical time constant can be eliminated by including a resistor in series with each relay coil. Value of the resistor should be at least 10 percent of the coil resistance. The switching transient cannot be completely integrated. Increasing the time constant of R_3-C_1 would slow the response of the fault detector. However, the effect of the switching transient can be masked by offsetting the null adjustment.

The gain of amplifiers V_{1A} and V_{1B} is 11. The half-wave peak signal at their inputs is 5.6 volts. Thus 60 volts appears across R_3 and R_4. The sensitivity of the differential amplifier is 100 μa output per volt of input change. The available signal when fault occurs is $1/30 \times 60$, or 2 volts. As relay K_1 requires only 80 μa to operate, there is more than 200 percent of the required differential signal.

This excess of signal is necessary to insure detection of all faults and to prevent false stoppages of the cycle timer. The drift of null is ± 20 μa per 24 hours. The initial offset of the null adjustment, to prevent switching transients from tripping the stop circuit, may be as much as -20 μa, referred to K_1 coil current. Thus, under the worst conditions, a total of 120 μa may be required to operate the fault detector; but this is well under the minimum current supplied by a 2-volt signal.

Reverse coil current in K_1 is limited by diode, D_1. As K_1 is a magnetically polarized unit its armature spring tends to bounce against the unused contact, especially when the null is depressed. The shunting diode effectively stops this action.

Power-line regulation is not required but it would improve null stability. Signal level changes caused by line fluctuations are compensated by similar changes in the reference amplifier input. The No. 47 lamp shunted by R_5 matches the nonlinear characteristics of the lamp strings. Trimming of this compensating circuit is best done experimentally. With a Variac, the line voltage is changed from 110 to 125 volts while the null is monitored by a VTVM connected to panel-mounted pin jacks J_1 and J_2. The null change should be less than 0.2 volt for the entire excursion.

It is necessary to have the cycle timer operating when final null adjustments are made. The procedure is to open S_1, which disconnects the stop circuit and reduces the cycling rate. Allow a 15 minute warmup. A 45-volt bucking battery in series with a vtvm allows the use of the 15-volt scale to monitor the signal amplifier output at J_2. Resistor R_6 equalizes the amplitudes of the NO and NC inputs. The vtvm without the battery is now connected between J_3 and J_4, and R_7 is adjusted to bring the reference amplifier to null. Finally, R_8 is adjusted to null with the vtvm connected to J_1 and J_2. Close S_1 and check the operation of the fault detector and stop circuits by removing lamps from the lamp panel. At the end of a one-hour test, the null drift measured at J_1 and J_2 should be noted and readjustments made.

In any relay test, the voltage applied to the coil is critical. Undervoltage will aggravate intermittent faults and overvoltage will mask them. The coil power supply provides nominal specified voltage for 30 spdt 24-volt, 3-ma units. A 2,000-ohm resistor is in series with each coil. An external power supply, adjustable and regulated, would provide the flexibility for testing a variety of relay types.

The cause of intermittent faults is, of course, contact contamination. Miniaturization aggravates the problem. Smaller armatures and coils, and lighter springs, make assemblies more difficult to adjust.

The cycling test tends to "run-in" the contacts. The majority of non-producible faults occurred early: in the first three minutes. The reproducible faults—those due to maladjustment—followed no particular pattern. Some were detected as late as forty-five minutes after the start. The run-in, therefore, tends to cure units of contact contamination and to permanently disable units having marginal assemblies.

TABLE I—CHARACTERISTICS OF INFRARED DETECTORS

	S-1 Response Multiplier[a] Phototube	Lead Sulfide 1[b]	Lead Sulfide 2[b]	Cooled Lead Sulfide	Indium Arsenide	Photo-conductive Indium Antimonide	Photovoltaic Indium Antimonide	Photoelectro-magnetic Indium Antimonide
Wavelength region (microns)	0.6—0.96	0.5—3	0.5—3	0.5—4.5	0.5—4.5	2—5.5	2—6	2—7
D* (a, b, 1) (watt^{-1} cm-cps$^{1/2}$)	D* (2,870, 1, 1)	D* (500, 90, 1)	D* (500, 750, 1)	D* (500, 780, 1)	D* (500, 750, 1)	D* (500, 900, 1)	D* (500, 500, 1)	D* (500, 500, 1)
@ 300 K detector temp	1.7×10^{11}	4.6×10^{8}	10^{9}	....	1×10^{10}	....	....	10^{7}
@ 220 K detector temp	7×10^{12}	....	....	$1—4 \times 10^{9}$	3×10^{10}	....	....	....
@ 78 K detector temp	....	....	....	$2.5—6 \times 10^{9}$	....	1×10^{9}	$2—15 \times 10^{9}$	...
@ 60 K detector temp	....	....	....	....	....	....	....	....
@ 20 K detector temp	....	....	....	....	....	....	....	....
@ 4 K detector temp	....	....	....	....	....	....	....	....
λ_{max} (microns)	0.8	2.1	2.3 — 2.7	2.4[c]—2.8[h]	3.7	5.5	5	6
$\lambda_{1/2}$ (microns)	0.6 and 0.96	*d* and 2.7	*d* and 2.7—3	*d* and 3.1[c]—3.4[h]	*d* and 4	2.8 and 6.1	2.8 and 5.7	2.8 and 6.9
D* peak (watt^{-1} cm-cps$^{1/2}$) for 2π steradians	1.3—1.6×10^{12}	8×10^{10}	1.6×10^{11}[e,f]	1.7×10^{11}[e]—6×10^{10}[h]	Not known	4×10^{9}	10^{10}—10^{11}	3.5×10^{7}
D* peak (watt^{-1} cm-cps$^{1/2}$) for 1 steradian	Not applicable	Not applicable	Not applicable	Not known	Not applicable	Not applicable	2×10^{10}—10^{11}	Not applicable
Recommended operating temp.	220 K	300 K	300 K	220 K or 78 K	300 K	78 K	78 K	300 K
Impedance (ohms)	Determined by the load resistance	0.1—10×10^{6}	0.1—10×10^{6}	0.5—5×10^{6}	20—50	40—200	100—100,000	5
Time constant (μsec)	0.02—0.04	500—1,000	10—1,000[f]	800—2,000	2—6	< 1	< 1	< 1
Available shapes	Circular	Any reasonable	Any reasonable	Any reasonable	Square, rect., round	Round, rect., linear arrays	Round, rect., linear arrays	Rectangular
Available sizes: side or dia (mm)	2.54 and 31	0.01—30	0.01—75	1—4	0.5—3	0.1—2	0.1—2	0.1—2
Approximate price	$110 and $275	$20	$15 up	$150	i	$650—$2,000	$500—$2,000	$250

(a) S-1 designation indicates response (to equal values of radiant flux at all wavelengths) peaking at 0.8 ±0.1 micron and with a half width about 2.5 microns surrounding the peak; subsidiary peak at 0.35 micron may be suppressed by window materials[5] (b) Can be immersed in strontium titanate (c) Can be immersed in germanium (d) Figure would be misleading for normal detector application (e) At 220-μsec time constant (f) $D^*\tau^{1/2}$ approximately equal to a constant (g) At

DETECTORS FOR

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OVER THE PAST FEW YEARS there has been a great increase in the use of infrared systems, particularly by the military, to detect small amounts of radiant power from the hot exhausts of jet aircraft, rockets and other targets. To meet the needs of the designer of such systems a variety of radiation detectors have been developed and a number of these have now reached the stage of manufactured stock components. Table I is a compilation of representative data on detectors that are important in military applications.

The majority of these detectors are photoconductive semiconductor devices. Incident radiation whose photons have sufficient energy (sufficiently short wavelength) cause an increase in the number of charge carriers available for conduction and therefore an increase in electrical conductance of the device. This change in conductance is sensed as a change in the voltage across the device when it is biased from a constant-current generator. For small signals the change in conductance due to radiation is proportional to the number of photons incident at appropriate wavelengths. The voltage signal is proportional

Lead Selenide[b]	Cooled Lead Selenide[b]	Lead Telluride	n-type Gold Doped Germanium	p-type Gold Doped Germanium	Zinc Doped Germanium-Silicon	Gold Doped Germanium-Silicon	Copper Doped Germanium	Zinc Doped Germanium	Thermistor Bolometer[c]
3—4.5	2—6	0.5—5.5	1—5.5	8—11	2—14	2—14	8—30	10—40	2—16
D* (500, 780, 1)	D* (500, 780, 1)	D* (500, 400, 1)	D* (500, 750, 1)	D* (500, 900, 1)	D* (500, 900, 1)	D* (500, 900, 1)	D* (500, 1,800, 1)	D* (500, 800, 1)	D* (500, 1, 1)
$1.9 - 3 \times 10^{7}$	....	....	....	....	....	....	....	....	10^{8}[h]
10^{9}	....	....	....	....	....	....	....	....	....
....	2.6×10^{9}	8×10^{8}	10^{10}	$1—3 \times 10^{9}$	....	....	....	....	....
....	....	....	....	$7—12 \times 10^{9}$	....	....	....	....	....
....	....	....	....	....	3×10^{10}[k]	3×10^{10}[k]	....	....	....
....	....	....	....	....	....	....	7[l], 4.4[m], $130^{n} \times 10^{9}$	4×10^{9}	....
3	5	4	j	5—6	10	9	25	36	10^{9}
1 and 4	2 and 6	*d* and 5.5	j	2.2—3.5 and 6.7—8	5 and 13	6 and 11	20 and 28	13 and 40	6 and 13[p]
2×10^{9}	1×10^{10}	1.5×10^{9}	j	$2—6 \times 10^{9}$	Not known	Not known	Not known	Not known	Not known
Not applicable	1.5×10^{10}	Not applicable	Not known	$3—10 \times 10^{9}$	Not known	Not known	4×10^{10}	Not known	Not known
300 K	78 K	78 K	78 K	78 K or 60 K	50 K	50 K	14 K	4 K	300 K
20×10^{3}—20×10^{6}	0.2—20×10^{6}	Not known	$2—10 \times 10^{6}$	$0.1—10 \times 10^{6}$	50×10^{6}	25×10^{6}	4,000	0.3×10^{6}	$1—5 \times 10^{6}$
2	10—40	10	50	0.1—1	<1	<1	1	0.01	1,000—20,000
Any reasonable	Any reasonable	Rect., round	Rect., round	Rect., round	Round shield aperture	Round shield aperture	Rectangular	Square	Rectangular
0.1—18	0.1—18	0.5—10	0.5—5	0.5—5	3	3	2	2	0.2—25
$10 up	$890 up	$500	$400	$750	$2,450	$2,450	$3,500	$9,000	$1,200

220 K (h) At 78 K (i) Price to be set early in 1961 when device will be available (j) Detector has unusual response that decreases with increasing wavelength (k) At 50 K or lower (l) At 74-deg field of view (m) At 60-deg field of view (n) At 12-deg field of view (o) For 4-msec time constant; D* proportional to $\tau^{1/2}$ (p) Determined by optical interference filter on KRS5; the long wavelength limit can be extended to 35 microns by a suitable window

INFRARED SYSTEMS

to this change in conductance. Thus the output voltage change is proportional to the change in incident radiant power causing it. The table contains exceptions to this operating principle in the form of multiplier phototubes, photovoltaic indium antimonide detectors and thermistors. Many infrared detectors must be cooled to low temperatures to show useful sensitivity.

Among characteristics of interest to the infrared project engineers: wavelength region of sensitivity determines target temperature for which a detector is most useful, impedance determines the difficulty of building a preamplifier to amplify the detector output without adding too much electrical noise, and time constant determines the rate of radiant power fluctuation that can be followed and, hence, usually the possible system scan rate.

In military applications infrared systems are almost always operated with so much amplification that sensitivity is limited by the size of radiant signal needed to produce a voltage or current bigger than the random electrical noise fluctuations in the system. Thus the sensitivity of an infrared detector is measured by the signal voltage to rms noise voltage ratio it will yield for a specified change in radiant power.

Several such criteria are in use but the most common is called the specific detectivity denoted D^* (a, b, 1). This quantity may be defined as the rms voltage signal-to-noise ratio at the output of a detector of area 1 cm² when it is uniformly illuminated with 1 watt of radiation from a source of temperature a, interrupted at frequency b cps, and the resulting signal and noise are filtered by an electronic filter with unit transmission over a band 1 cps wide centered at frequency b and zero transmission at other fre-

TABLE II—DETECTORS AND TYPICAL MANUFACTURERS

Cooled Lead Sulfide	Santa Barbara Research Center, Goleta, Calif.
Copper Doped Germanium	Santa Barbara Research Center, Goleta, Calif.
Gold Doped Germanium	Philco Corp., Lansdale Tube Div., Lansdale, Pa.; RCA, Electron Tube Div., Harrison, N. J.; Santa Barbara Research Center, Goleta, Calif.; Westinghouse Electronics Corp., Semiconductor Dept., Youngwood, Pa.
Gold Doped Germanium-Silicon	RCA, Electron Tube Div., Harrison, N. J.
Indium Antimonide	ITT Labs, Fort Wayne, Ind.; Philco Corp, Lansdale Tube Div., Lansdale, Pa.; Radiation Electronics Co., Chicago, Ill.; Texas Instruments Inc., Dallas, Texas
Indium Arsenide	Philco Corp., Lansdale Tube Div., Lansdale, Pa.
Lead Selenide	Eastman Kodak Co., Military and Special Products Sales, Rochester, N. Y.; Electronics Corp. of America, Cambridge, Mass.; Infrared Industries Inc., Waltham, Mass.; Santa Barbara Research Center, Goleta, Calif.
Lead Sulfide	Bulova Research and Development Labs, Woodside, N. Y.; Eastman Kodak Co., Military and Special Products Sales, Rochester, N. Y.; Electronics Corp. of America, Cambridge, Mass.; Infrared Industries Inc., Waltham, Mass.
Lead Sulfide	ITT Labs., Fort Wayne, Ind.
Multiplier Phototubes	ITT Labs., Fort Wayne, Ind.; RCA, Electron Tube Div., Harrison, N. J.
Thermistor Bolometers	Barnes Engineering Co., Stamford, Conn.; Servo Corp. of America, Hicksville, N. Y.
Zinc Doped Germanium	Perkin Elmer Corp., Norwalk, Conn.
Zinc Doped Germanium-Silicon	RCA, Electron Tube Div., Harrison, N. J.

quencies. It is necessary also to specify the temperature of the detector and, for the longer wavelength detectors, their field of view and the temperature of the background (usually room temperature). For small changes by a factor of two or three in area or electrical bandwidth, the quantity of radiant power which will produce an rms voltage signal-to-noise ratio of 1 is given by $P_n = (Ad)^{\frac{1}{2}} (\Delta f)^{\frac{1}{2}} / D^*$, where P_n is noise equivalent power in watts, Ad is detector area in cm^2, Δf is noise equivalent bandwidth of the amplifier with which the detector is used in cps and D^* is the specific detectivity in watt^{-1} cm-cps$^{\frac{1}{2}}$. For larger changes in area or bandwidth or for changes in operating frequency, temperature, source temperature, or field of view, extrapolations should be made only with care and should be based on measured parameters obtained from the manufacturer or from the referenced reports.[1, 2] Detailed accounts of the factors involved are given in Jones[3, 4] and other references cited there.

The specific detectivity is also quoted in Table I for incident radiation of the wavelength to which the detector responds best. This quantity D^* (λ_{max}, b, 1) is usually called D-star-peak. Because the sensitivity of cooled long wavelength detectors may be limited by photon noise generated by background radiation, D^* peak is listed for some of these detectors with a field of view of 2π steradians and 1 steradian. The table also lists λ_{max}, the wavelength of maximum response, and $\lambda_{1/2}$, the wavelengths at which response is half of maximum.

The values quoted in Table I are typical values collected from manufacturers' literature. Often a manufacturer can select and supply detectors two or three times more sensitive than typical detectors at an increase in price. Prices quoted are for a quantity of one, in a stock size and package. Typical manufacturers and their detectors are listed in Table II.

Uncooled lead sulfide detectors have been in production since the second world war and are made by a number of manufacturers. Differences in technique lead to a large variety of detectors with slightly different characteristics. It has been chosen to let two examples stand as representative of the range. It is assumed that the principal function of Table I will be to lead the prospective user to other sources of more detailed data.

A number of detectors have not been included. Silicon solar batteries are useful photovoltaic detectors for radiation of wavelengths shorter than about 1 micron but have not yet been optimized as detectors rather than power sources. Various detectors use physical properties which change as their temperature is increased by absorption of radiation. These detectors include thermocouples, gas expansion devices, materials which evaporate or change refractive index with temperature, etc. They are useful for spectroscopy or chemical process control but are usually too slow for military applications (one exception which is listed is the thermistor bolometer). Some detectors have been omitted including tellurium, gallium arsenide, and cadmium-doped germanium because they seem still to be under development. However indium arsenide has been included because development is claimed almost complete. One has been omitted for reasons of security classification. Several other special devices have been omitted such as image tubes and a radiation tracking transducer.

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Electronic Fader for Auditory Research

Electronic switch fades audio signals on and off without producing audible switching transients. Circuit does not require matched tubes or critical components

By E. de BOER, Universiteit van Amsterdam, Wilhelmina-Gasthuis, Amsterdam, The Netherlands

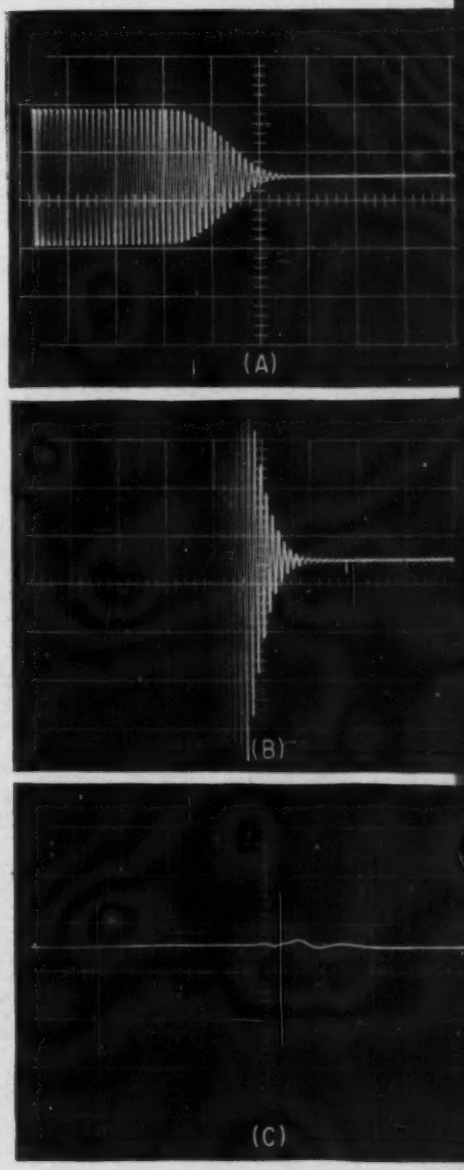
SIGNALS USED in auditory research are usually generated from low-frequency sources and frequent use is made of modulation. In such low-frequency work, it is important to be able to switch auditory signals off and on without producing audible clicks. The principal difficulty resides in the so-called switching transients, spurious signals that occur during switch-over. Not all commercially available electronic switches are suitable for this audio work, and in many laboratories new designs are being developed.

This article describes an electronic switch or electronic fader that fades l-f signals in and out without audible clicks—transients are compensated by a correction circuit so that even unmatched pairs of modulator tubes can be used. The circuit contains no balancing transformers and the like, so that the signal undergoes little distortion. A push-pull output decreases distortion still further.

Multigrid tubes like those of Fig. 1A allow for compensating switching transients. Suppose the total d-c cathode current of such a tube is constant, independent of the control grid voltage. (Small modulations of this cathode current represent the carrier signal.) Part of the cathode current goes directly to the anode, the remainder flows to the screen grids (2 and 4). When the tube is switched OFF, all current is forced to the screen grid 2. The sum of anode and screen currents is constant. Now, if the a-c fluctuations could be removed from the screen current, the resulting d-c screen current could serve as the required compensation current. This d-c current could subsequently be added to the anode current so that the d-c component of the resulting current remained constant. To do this, the tube is coupled to a second, similar tube, to which the same control signal is fed. The carrier signal of the second tube, however, has opposite phase. The screen grids of both tubes are connected so that the a-c components of the two screen grid currents cancel. A d-c screen current is obtained that is twice as large as that required for compensation. One-half of the total screen current is fed to each anode, yielding automatic compensation of switching transients. The basic configuration is shown in Fig. 1A. The control signals required for the two tubes are the same. They need not be in push-pull which would be cumbersome for slowly varying d-c voltages. Also the circuit always shows balanced operation; any a-c unbalance of the screen current is automatically divided between the two anodes.

However, differences in tube characteristics will cause a switching transient in the voltage difference between the anodes—this problem is discussed following the description of the basic system.

Since a large cathode resistor causes a signal voltage between control grid and cathode that increases distortion, a cathode resistor should be avoided. Cathodes should be grounded or the lower part of the tube should be used as a grounded-grid amplifier. In the latter case



Oscillograms show end of signal burst (A), with sensitivity of 1 v per cm; single-ended output (B), sensitivity of 0.1 v per cm; and typical switching transient at minimum position (C), with sensitivity of 0.1 v per cm

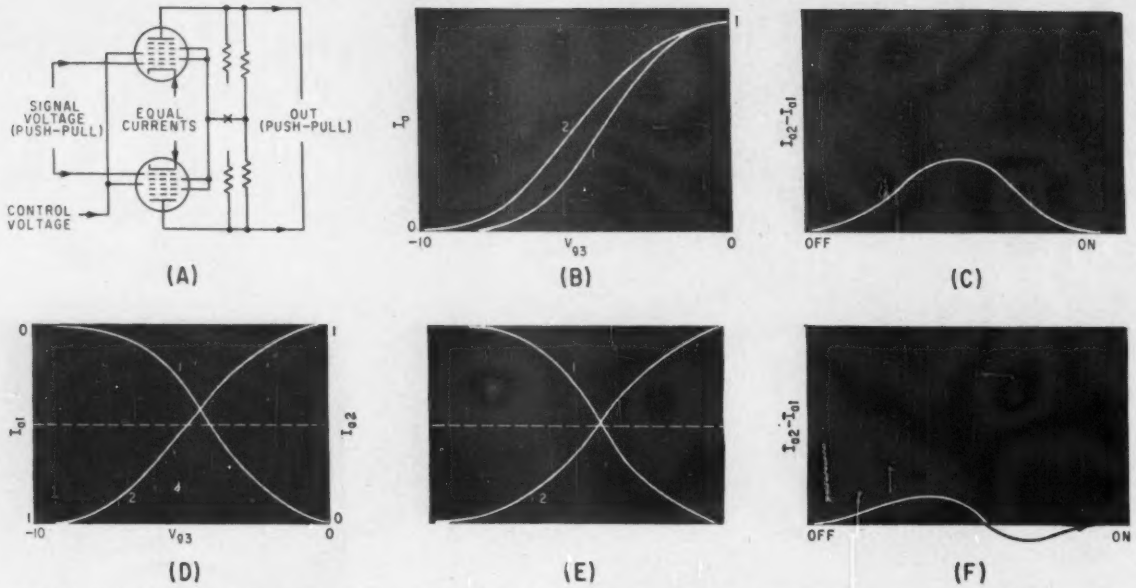


FIG. 1—Basic circuit of the fader (A), and analysis of heptode control characteristics showing the origin of switching transients (B to F). With no carrier signal, the switching transient has the shape shown in (C). When the intersection point has been compensated exactly, the switching transient has the form of (F)

the grids are grounded and the cathodes fed by pure current sources. Inserting a grounded-grid triode at point x in Fig. 1A keeps screen-grid voltage reasonably constant so as not to interfere with the regulation. The current passes through the triode unchanged; it divides into two parts subsequently. Therefore, with respect to the heptodes, the triode acts as a cathode follower and thus stabilizes the screen voltage.

For correct operation of the circuits two primary conditions have to be met. First, the d-c currents of the heptodes must be equal. Second, the a-c (carrier) signals must be in push-pull, so that perfect suppression is obtained in the OFF position. Both of these conditions can be achieved.

It remains now to equalize the regulation characteristics of the two heptode tubes to eliminate the switching transient as much as possible. If, at any moment during the switch-over, the two tubes do not have equal anode currents, the total tube space currents, after each accepts one-half of the screen current, will still not be equal. A voltage difference will develop between the anodes that is indistinguishable from the desired signal. This voltage difference is the switching transient; with correct setting, it appears only during switch-over. It is present irrespective of whether a carrier signal is applied or not.

Figure 1B shows the control characteristics of the two heptodes. Both go from zero to maximum, the two maxima being set equal (equal d-c cathode currents). If there is no carrier signal, the output voltage is proportional to the difference between the functions. The switching transient hence has the shape shown in Fig. 1C. The situation of Fig. 1B is repeated in Fig. 1D, but with the curve of I_{a_1} plotted upside-down. The curve of Fig. 1C also represents the sum of the functions of Fig. 1D. At the intersection point of the two curves the sum is larger than unity, which causes the output signal to be positive. Thus, curve 2 must be shifted somewhat to the right and curve 1 somewhat to the left. This is done by adding a constant voltage to the control voltage at the grid of tube 1 and subtracting the same voltage from the control voltage at the grid of tube 2. The result is shown in Fig. 1E; the switching transient has the form of Fig. 1F. The intersection point has been compensated exactly. A further improvement comes from varying the slopes of the control characteristics while keeping the intersection point invariant. This will decrease the amplitude of the lobes of the switching transient until their inequality becomes the major limit. To achieve this, one of the control signals is expanded around the intersection point, the other is contracted in the same ratio. In most cases this yields excellent results from unmatched pairs of tubes. It is applicable not only to this type of fader but can be applied as well to almost any modulator and in many cases where tubes should be matched to a high degree. Further improvements could be obtained by continuing the same procedure; for example, by applying parabolic voltage transformations.

Figure 2C shows a detailed circuit diagram of one fader. This is driven by a driving unit, Fig. 2A. Both circuits are built in duplicate, and fed by a common power supply. Cascading of both faders ensures large suppression in the OFF position, which is necessary in working with short auditory signals. In the fader unit (Fig. 2C) the carrier

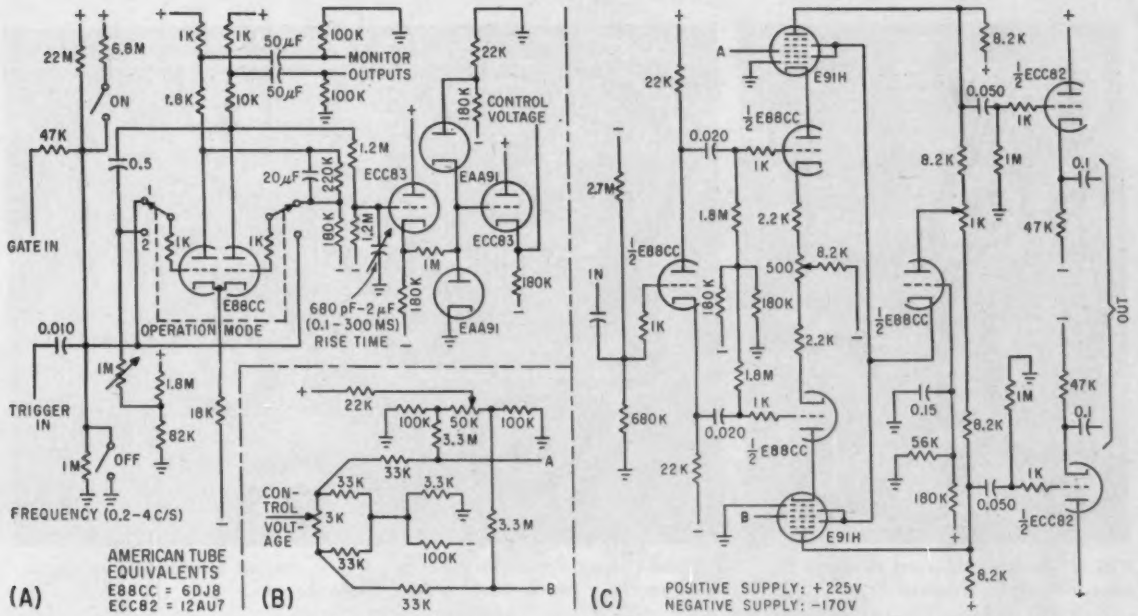


FIG. 2—Electronic fader circuit (C) is driven by the driving unit (A) whose operation mode 1 is triggered or gated and operation mode 2 is free running. Fader and driver are connected by the correction network (B) that minimizes switching transients. Circuits (C) and (A) are built in duplicate and fed by a common power supply

signal is fed in push-pull to two driving triodes that have a fairly large current feedback. Not only is distortion reduced, but the triodes operate successfully as current sources as seen from their anodes. The currents constitute the cathode currents of the heptodes. Two cathode followers form the output circuit; the output signal can be taken off either in push-pull or single-ended.

In the cathode circuit of the driving triodes a balancing adjustment is provided. This controls d-c as well as a-c balance, but not necessarily at the same setting. The control should be adjusted for a-c by obtaining minimum output signal in the OFF-position. Any remaining difference of the d-c currents is taken care of by an adjustment potentiometer in the bypass-current circuit. The latter adjustment is also used to compensate for a possible difference between the anode-to-screen current ratios of the two heptode tubes. The a-c balance should be set before the d-c balance is restored. The driver unit (Fig. 2A) consists of a multivibrator and a pulse-shaping circuit. The multivibrator can be used either as a free-running device or as a Schmitt trigger circuit. Selection is by a DPDT switch. In the free-running position only one capacitor is in the circuit. At proper adjustment this causes an on-off ratio of unity. The period can be adjusted from 0.1 to 1.5 seconds; it can easily be synchronized (by the carrier signal) to switch at a constant phase. In the trigger position the circuit can be switched on by a positive input pulse and off by a negative input pulse of 20 volts. It also can be gated by a voltage of +20 volts. The output block voltage is shaped into a trapezoid form by integration and subsequent bipolar clamping. Care is exercised to make these two operations independent and to provide a low output impedance.

The driver and fader units are connected by the correction network shown in Fig. 2B. At the left is the slope correction, and at the top, the shift of the cross-over point. The cross-over point should be adjusted before making final adjustment of the slope control. The waveforms obtained during switch-over indicate some interdependance between these controls. In addition, the correction controls influence the d-c balance because the control grid of the heptode is not driven into saturation (grid current). The d-c current passed to the anode thus never becomes maximal and is subject to variation. The units are fed from a well-stabilized supply, having less than 2 millivolts ripple and a low internal resistance (of the order of one ohm) at both supply voltages. Filament voltage of the heptode must be correct to avoid drift; the filament voltage need not be stabilized however. The waveforms show the operation and the switching transient. The suppression in the off position is determined mainly by distortion. If push-pull output is used, however, the distortion is much less and the carrier signal is at least 60 db below maximum value. The switching transients remain with the same relative amplitude.

The final unit is built on a ventilated chassis for rack mounting.

This circuit was investigated and built during a research program on auditory analysis, sponsored by the Organization for Applied Research (T.N.O.), The Hague. The help of P. W. Melk and A. J. Heerding in the development and construction of the circuit is gratefully acknowledged.

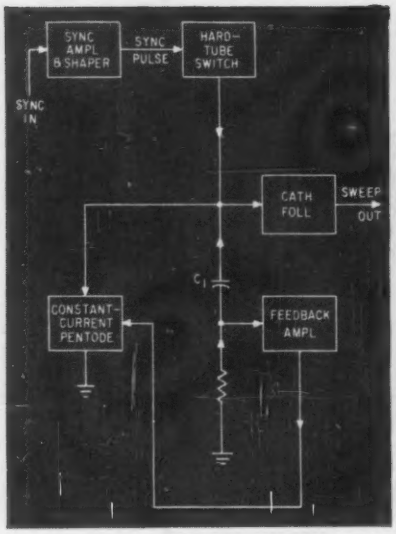


FIG. 1. Sync pulse input to sweep generator triggers sweep

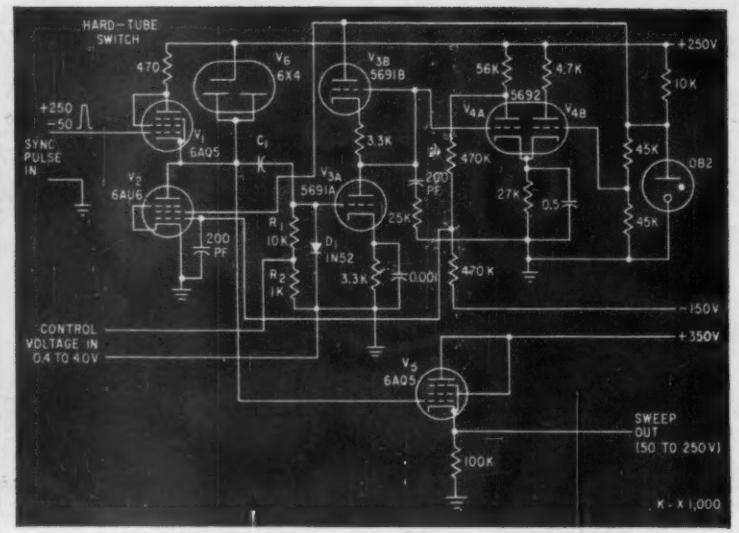


FIG. 2—Circuit details of sweep generator. Output of the generator goes to an amplifier which drives a deflection yoke

High-Precision Sweep Generator

Maximum variation in length of sweep produced by this highly precise generator is less than 1 part in 1,000

By EDGAR W. VanWINKLE,
Sr. Project Engineer,
Eclipse-Pioneer Div.,
The Bendix Corp., Teterboro, N. J.

THIS sweep generator was designed for an electronic high-definition facsimile recording system.[1, 2, 3] Requirements for the sweep generator were severe. Maximum variation in sweep length had to be one part in one thousand, since the facsimile system was such that sweep-length or sweep-rate variations greater than 1 part in 1,000 severely distorted information.

The sweep generator, shown in Fig. 1, has sweep variations of less than 0.01 percent of sweep length. After C_1 is charged through the hard-tube switch, C_1 discharges into a constant-current pentode controlled by current feedback in a modified Miller-feedback circuit. Sweep rate can be controlled over a 10:1 ratio. Repetition rate (in seconds) can be varied from 0.1-to-1 times the value of capacitor C_1 in μf. A range of time between 0.00005 sec and one hour is obtainable. Regulation of filament voltages and double-regulation of the B+ supply is essential to obtain the required stability.

As shown in Fig. 2, a sync pulse triggers switching tube V_1, thus charging C_1 through D_1. Discharge current of C_1 is controlled by constant-current pentode V_{2b} which in turn is controlled by a modified Miller-feedback circuit. The capacitor discharge current is measured by the resistance between the grid of V_{3A} and ground; this resistance is effectively that of R_1. The voltage across R_1 is amplified by V_{2a}, which is used as a series-triode amplifier to eliminate the effect of heater-temperature fluctuations with line voltage. Output of V_{2a} is amplified by V_{3A}, which is used as a differential amplifier to use the high-level output of V_{2a} and to provide some immunity from heater-voltage variations. The output of V_{3A} is fed to the control grid of V_{2b}, which discharge C_1 at a fixed rate determined by the control voltage input.

The discharge of C_1 generates the sweep voltage. It is well known that the voltage developed across a capacitance C at a time T is given by

$$V = (1/C)\int_0^T i\,dt + V_0$$

where i is the current into the capacitance and V_0 is the voltage on the capacitance at $T = 0$. If i is constant, $V = V_0 + jT/C$. Thus, sweep voltage V is a linear function of time. This varying voltage, which is the integral of the voltage at the control voltage input, is available at the plate of V_{2a}. To obtain this voltage at a lower impedance level, the plate of V_{2a} is connected to the grid of V_5, a cathode follower having a high input impedance. The sweep output appears at the cathode of V_5.

To achieve sweep accuracy, feedback-amplifier gain was set at 55 db. Tube V_4 controls the start of the sweep, thus reducing variations in the voltage at the start of the

CIRCLE 88 ON READER SERVICE CARD→

Raytheon Fire Control Radar System installed in newest missile destroyer

Raytheon AN/SPG-51 fire control radars are operational aboard the U.S.S. CHARLES F. ADAMS (DDG-2). As the Mark 74 Fire Control Systems Coordinator for the Bureau of Naval Weapons, Raytheon is carrying out serial production of the advanced design AN/SPG-51.

The ADAMS, first destroyer built from the keel up to launch guided missiles, carries out its Anti-Air Warfare mission with TARTAR surface-to-air missiles. The radar tracks intruders and guides the missile even to low altitude targets despite the use of evasive tactics or electronic countermeasures.

Each AN/SPG-51 consists of a single dish tracking and guidance radar. The radar tracks at long ranges with exceptionally low power.

Upon assignment, AN/SPG-51 automatically acquires and tracks the target. Seconds before missile launch, the target is illuminated with a guidance beam. The missile homes on the reflected signal.

The AN/SPG-51 features excellent sub-clutter visibility and exceptional techniques to resist jamming. Selected by the Bureau of Naval Weapons for guided missile applications, this is the first fire control radar of its type to be procured in quantity.

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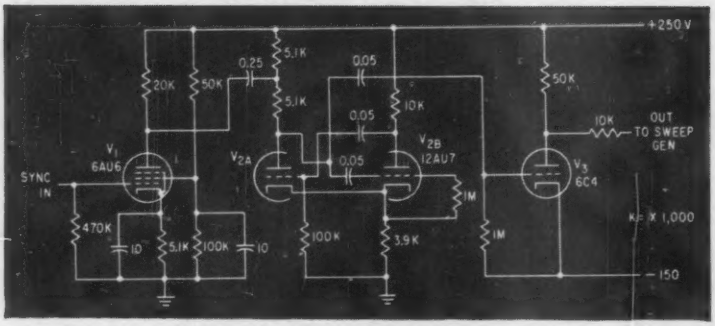

FIG. 3—Input to sync-pulse amplifier and shaper gives a 300-v output pulse

sweep; such variations could be caused by circuit inductance.

The sweep generator was designed for a range of 50 to 500 μa of discharging current over the 10-to-1 range of control voltage inputs. This current depends on the control-voltage-input setting, which may be set between 0.4 and 4 v, 4 v being near the limit for satisfactory operation. At 4 v, the sweep current is 500 μa and the length of the sweep in seconds equals the size of capacitor C_1 in μf. Output voltage is the integral of the control voltage input as long as this voltage stays within the range of 0.4 to 4 v.

Sweep-generator stability is obtained by controlling the discharge current of C_1. The capacitor discharges through V_2, producing a negative voltage across R_1. Any variation of this current is amplified 55 db by V_2 and V_1 before going to V_3. An increase of capacitor current would produce a more negative voltage at the grid of V_{2A}, a more positive voltage at the grid of V_{2B}, and a more negative voltage at the grid of V_2; hence this sequence would increase the plate resistance of V_2, thus causing a decrease of capacitor current. Feedback thus stabilizes the capacitor discharge current, producing a linear and stable sweep generator. The main stability-limiting factors are the loading of V_3 and leakage across C_1.

The circuit shown in Fig. 2 has produced sweeps at rates between 15,000 cps and 1 cycle per hour. Linearity of 2 percent was obtained at a rate of 1 sweep per hour and a linearity of 0.1-percent or better obtained at the higher rates.

The return-trace time of the sweep is determined by the shape of the sync pulse. The return trace can be made as short as 0.1-percent of the sweep time without damage to switch tube V_1. The sync-pulse-shaping circuit is shown in Fig. 3. This circuit consists of an amplifier coupled to a plate-driven one-shot multivibrator. The time constants of the multivibrator give the return-trace time. The output of V_2 is a 50-v negative pulse that is coupled to V_3. Tube V_3 has its grid and cathode returned to -150 v and its quiescent plate voltage is -50 v. The pulse from V_2 cuts-off V_3, bringing its plate voltage up to $+250$ v. This 300-v pulse is applied to the grid of V_1 in Fig. 2. Tube V_1 (Fig. 2) then charges sweep capacitor C_1. The voltage at the cathode of V_1 rises to about 250 v for the duration of the pulse. If the voltage across C_1 is greater than 250 v, at the end of the sync pulse C_1 discharges through V_4 at a rate determined by the size of C_1 and the resistance of D_1. This time is a few μsec. Sweep starting voltage is thus set by V_4 and the precision regulated voltage applied to the cathode of V_4.

Starting the sweep at a precise repeatable voltage and regulating the discharge current of C_1 produces a linear and stable voltage change. Tube V_3, which reproduces this change at a lower impedance level, must be selected for low grid current to avoid nonlinear sweeps.

The power amplifier for the sweep generator is shown in Fig. 4. Output voltage from the sweep generator is large enough to eliminate any voltage-gain requirement of the power amplifier. The sweep-voltage accuracy is such that it cannot be amplified without seriously degrading the signal.

Power-supply regulation is 0.5 percent for the 350-v supply and 0.01 percent for the 250-v supply. Impedance of the 250-v supply is less than 0.2 ohms. A step change of 0.3-amp load current causes a voltage variation of only 1 mv. The power supply also provides filament regulation of V_1 and V_2 of Fig. 2. These specifications are necessary to obtain a sweep stability of one part in ten thousand.

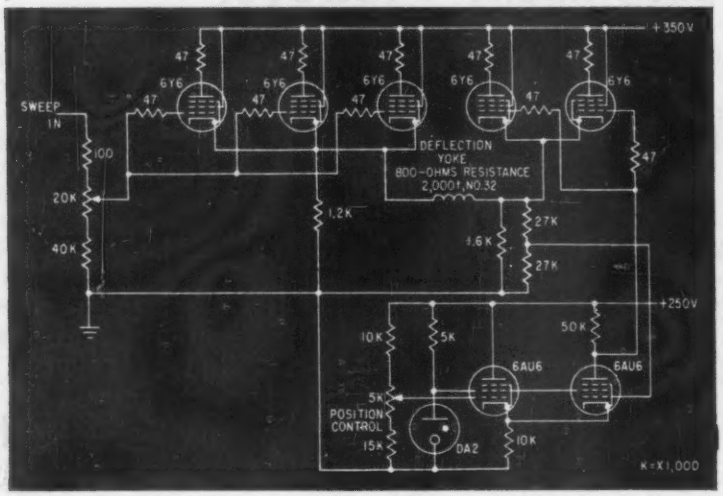

FIG. 4—Sweep input from generator drives sweep amplifier

REFERENCES

(1) "Facsimile Recorder System", Patent 2,946,848.
(2) "Frequency Control and Synchronizing Circuit", Patent 2,940,052.
(3) Patent Application 414,910, on Sweep Generator, filed Mar. 8, 1954.

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CIRCLE 91 ON READER SERVICE CARD 91

German Traffic Analyzer Uses Doppler Principle

By JAMES MORRISON,
McGraw-Hill World News, Bonn, Germany

VEHICLES travelling on highways can be counted and then classified according to size as well as speed by a working model of a new type of traffic analyzer. Discrimination can be made between motorcycles, automobiles, trucks, and truck-trailer combinations. Detectable speed range is between 15 and 70 miles an hour increasing in increments of about 3 miles an hour.

The system was recently exhibited at the INTERKAMA (West Germany's International Congress and Exhibition of Measurement Instruments and Automation) by its manufacturer, Telefunken of Berlin and performed with a maximum analysis error of less than three percent.

Operating on the Doppler principle, the German system has an advantage over other radar speed detecting systems in that it uses a much narrower beam of detecting rays which are formed by a tubular antenna. Half angle of the beam is between six and ten degrees. The narrow beam limits scanning to a single traffic lane so that only vehicles in that lane will be detected and analyzed.

The frequency of the return signal from individual vehicles varies with vehicle speed in accordance with the Doppler principle. A phase detector compares the return wave with the transmitted wave to obtain a signal having an amplitude proportional to the phase difference of the two signals. As the vehicle travels a quarter wavelength, the total transmitted and return signal distance is decreased by a half wavelength. Thus, with each such movement, alternate variations in the detector output current is set up, and the total number of periods recorded in this cycle will be a direct measure of the distance the vehicle has moved under the beam to give direct indication of vehicle length as well as speed.

When positioning the equipment, the scanning beam has to be arranged so as not to impinge on the vehicle wheels whose rotation will give indication of spurious varying speeds. Telfunken has taken into consideration the differences in angle inclination of the impinging wave as the vehicle enters and leaves the beam. Since this causes slight variations in the resulting detector current, circuitry has been incorporated that compensates for such variations.

Traffic analyzer positioned on highway overpass. Note tubular antenna

The equipment will register correctly only if certain minimum spacings are maintained between vehicles. These distances are calculated to be about five feet between rear of one vehicle and radiator of following vehicle. If the beam is arranged vertically to the center line of a traffic lane, minimum distance can be three feet. However, best results are obtained with spacings not less than thirteen feet.

Practicality of the system (and its low cost of $7,150) can be traced to the use of three-centimeter equipment. As this equipment is barred in the U. S. except for marine and air-safety puposes, its price here would be doubled since Telefunken would have to design and install 12 centimeter or 8 millimeter equipment conforming to U. S. specifications.

To date, certain modifications have been noted on the prototype now being field-tested. Very careful setting is required to obtain accurate speed determination and occasionally it is difficult to differentiate between a motorcycle and a small motor car. Vehicles not travelling centrally along a traffic lane may cause faulty registration, particularly if they happen to be the aforementioned types. Results, however, have shown that losses due to such effects are less than 3 percent of the total even when scanning heavily-frequented rural high-

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where the electronics industry can best grow. Basic to the electronics industry are the technical skills and experience of capable men and women—those adept at developing, producing and testing intricate equipment. In this respect Southeastern Michigan has the advantage. Here is plenty of skilled manpower to produce complex and sensitive missile guidance computers, data processing systems, communication equipment and the like.

Southeastern Michigan possesses other resources of prime interest. Respected universities are nearby. Their proximity and reputations encourage graduate work. They make staff members available as industrial consultants; undertake on-campus research and development for industry.

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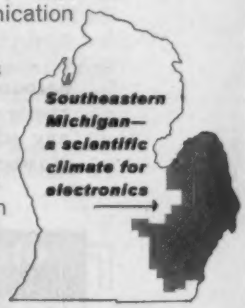

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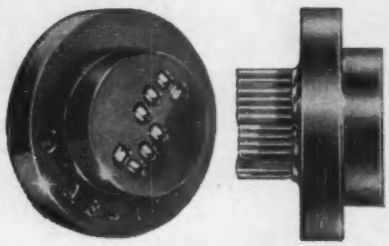

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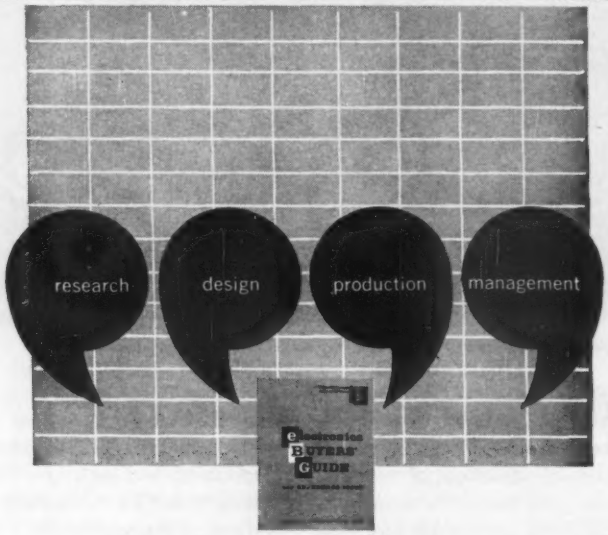

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ways with many vehicle types.

The analyzer system can be connected to a punched-card unit, photography unit, or with any other means of recording numbers automatically and permanently.

Presently, Telefunken is building a prototype for incorporation in a minibus. The antenna will be mounted on an arm extending over the bus roof. After field trials, this equipment is slated for delivery to the German Federal Ministry of Highways in January.

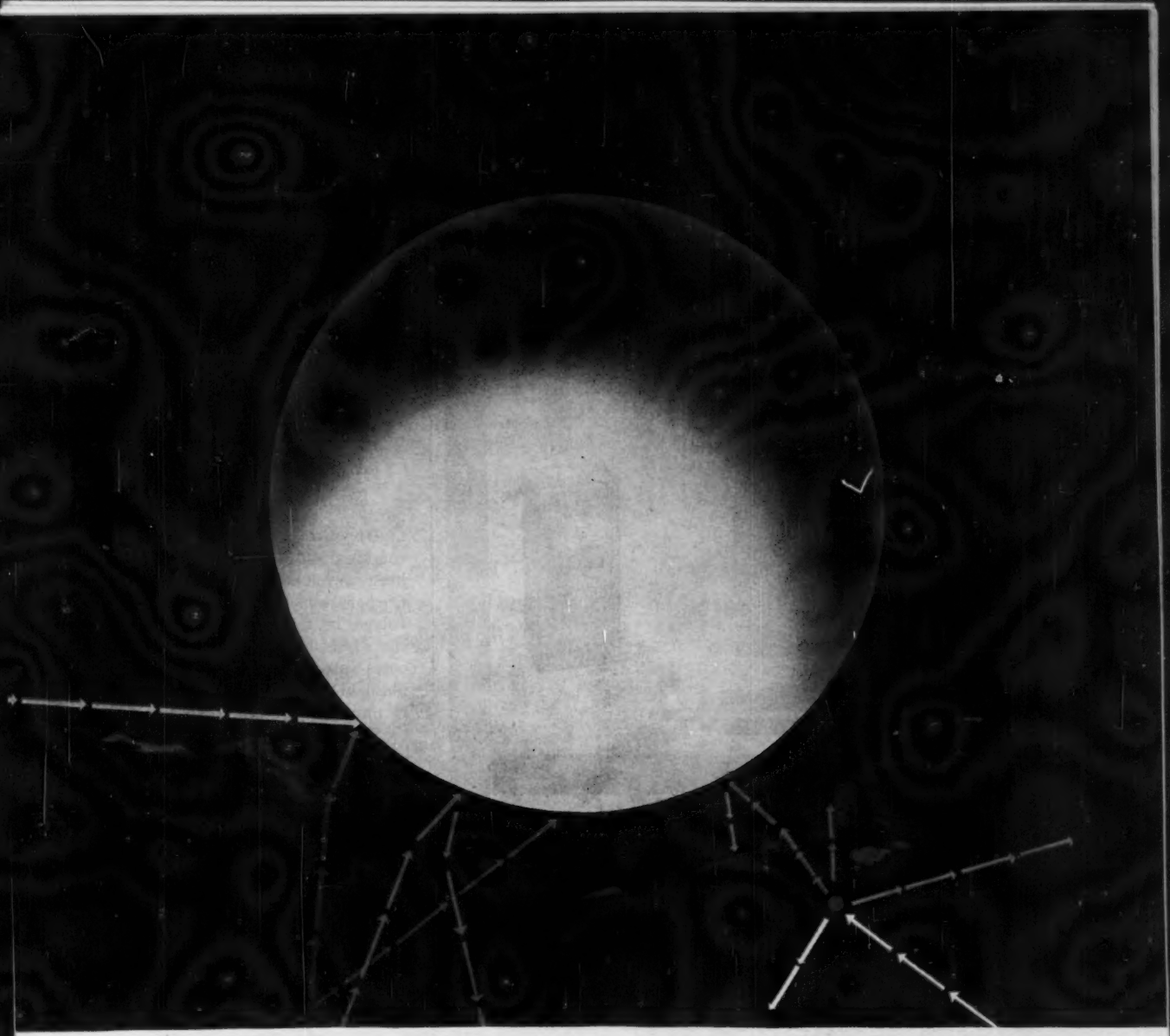
Automatic Weather Station

COMPUTERS continue to receive important consideration by the U. S. Weather Bureau and the National Bureau of Standards. For a number of years, the Weather Bureau has been appraising the possibilities of widely distributed automatic weather stations that would include computers receiving data from weather-sensing instruments and processing the data through such functions as sampling, comparing, selecting a maximum and arithmetic operations. A central forecasting station would receive results by teletype.

The various development concepts of weather computer stations have been called AMOS (Automatic Meteorological Station) and the current transistorized version is known as AMOS IV.

Several of the input quantities to the AMOS computers, such as cloud height and precipitation, cannot be satisfactorily represented by instantaneous values but must be time-averaged. Isolated development of units for processing individual measurements and many functions were therefore duplicated in earlier weather-station computers.

In AMOS IV, the automatic weather station is built around a single small general-purpose computer. Data from the input instruments is received at any desired interval and in simple form such as analog voltage, current, resistance, pulse rate, and contact closure representing temperature, dew point, wind speed and direction, atmospheric pressure, precipitation, transmissivity, and cloud height. Information may also be in digit



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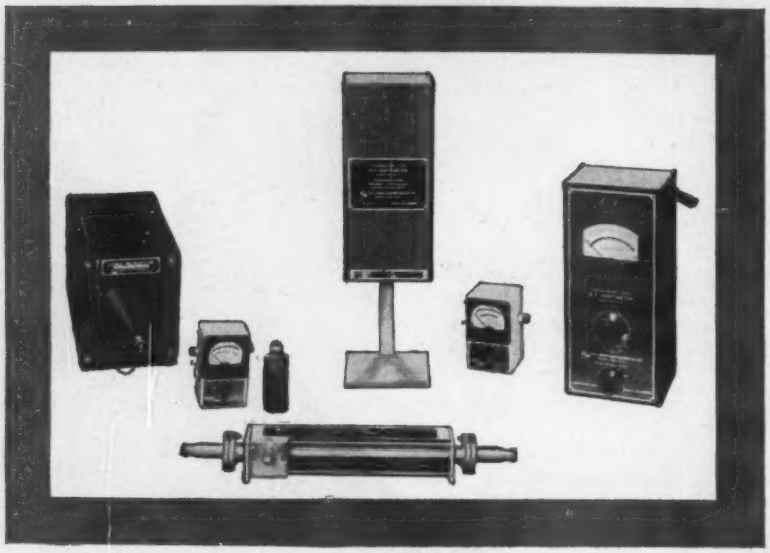

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coded form, but the nature of weather instruments and of the quantities measured limits the input data to 2 or 3 decimal digits for the most part; word size is therefore 3 digits plus sign. Double-precision methods are available for those few instances requiring greater accuracy.

Storage is done with a magnetic drum operating at 1500 rpm, carrying 100 general storage channels of 100 words each, and having space for 100 additional channels.

Hydrogen Atoms and Light Bulbs

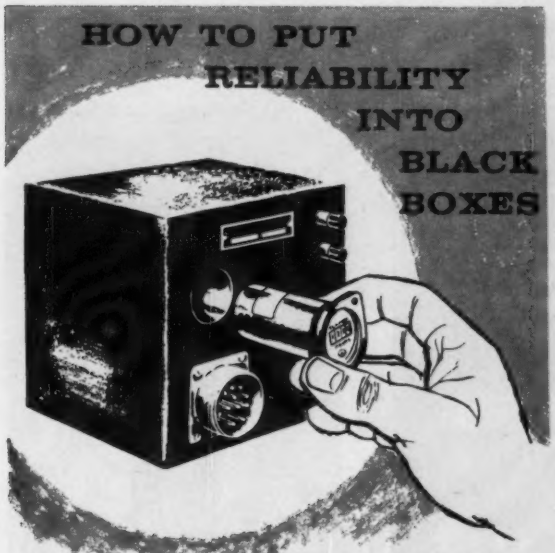
LIGHT BULBS operating on the recombination of hydrogen atoms has been developed by the Duro-Test Corporation. The principle involved in the new light source is the dissociation of hydrogen molecules into atoms at a hot tungsten filament and their subsequent recombination on the phosphor coated bulb wall. The heat released excites luminescence in the phosphor substance. Through the proper selection of phosphor coating, a far greater variety of colors can be obtained.

A basic patent has been granted on this development.

Also projected by Duro-Test for commercial purposes are the triple-arc xenon light bulbs capable of projecting light rays a distance of fifty miles. Presently xenon bulbs are being used in military and space applications.

TV and Astronomy

TELEVISION has found a new research application in astronomy. An astronomer, Dr. William Livingston of the Kitt National Observatory, has used television to record the light (picked-up by the U. of Arizona 36-inch telescope) issuing from the Globula Cluster M 15 tens of thousands of years ago. Livingston says that television is more sensitive than a photographic plate by a factor of 50 to 100—in other words, exposures have to be 50 to 100 times longer with photography. Television, he said, will make it possible to take many more pictures during a night's work.



"INDEX OF RELIABILITY" . . . Mean Operating Time Between Failures.

Reliability and Maintainability are always important — and most often very critical factors. Their definitions invariably involve "time". Some military specifications use "mean operating time between independent failures" as the index of reliability and call for the incorporation of elapsed time indicators into the operating equipment. Replacing critical components before they reach the limit of rated life contributes greatly to peak operating efficiency and reliability.

Waltham's subminiature elapsed time indicators are being used and designed into both military and commercial equipment for ground support and airborne applications. They are small and light enough to go anywhere. Jewel bearings, precision gear trains — some with a reduction of 1.8 billion to 1, a new low inertia synchronous motor are teamed with over 110 years of experience to provide instruments reliable and accurate enough to provide precise "measures of reliability".

Waltham can provide subminiature elapsed time indicators in both digital and dial readouts — and in production quantities. Write for bulletins #5001 and #5002 or telephone TW 3-4000

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Solid State PCM Simulator ESS-500 by Telemetrics

Realistic preliminary checkout of PCM telemetry ground stations assures reliable results in performance. The Electronic Signal Simulator ESS-500 by Telemetrics, Inc. gives this assurance . . . simulates the digital output of an airborne or ground multiplexer and digitizer for both calibration and checkout . . . presents serial input data . . . applicable also in research and development of pulse coded systems.

Versatile Signal Simulator provides for word length selection, master sync code, 0-to-full scale coding, and 11 special data codes . . . through use of plug-in units, can generate binary, binary-coded-decimal, excess three, biquinary, or any other digital code. NRZ and RZ output signals are provided at +20 volts and —10 volts for full scale; with zero volts for zero scale. Completely transistorized unit occupies only 5¼-inch panel space in standard 19-inch relay rack.

Telemetrics, Inc.

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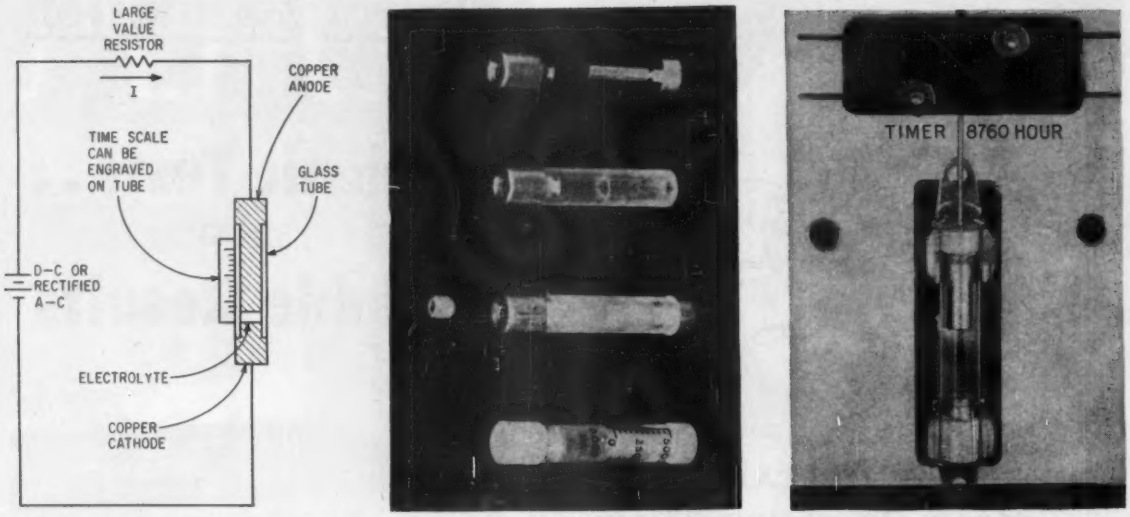


Miniature electroplating bath in cell, (left), is a trade secret. Simple, inexpensive device measures length of time electronic equipment has been in operation. Details of cell are shown, (center). One of many uses includes a long-time-delay relay, (right). Here a loaded micro type switch is tripped at a designated time, with no need for auxiliary relays or switches. Marketable timers for the full range of temperatures from —55 C to 85 C should be available soon

Electrochemical Elapsed-Time Indicator

DETERMINES TIME-TO-FAILURE OF COMPONENTS

By M. HOBERMAN, Chief Engineer, Bergen Labs. Inc., Paterson, N. J.

CONVENTIONAL METHODS of time measurements generally use a mechanical device such as a clock or an electrical motor in the form of an ordinary electric clock. These devices have considerable limitations in size and cost.

The need for a simple, small timer, so cheap that it could be used in virtually every piece of electrical equipment and take up no more than, say, a cartridge fuse, led to the development of an elapsed-time indicator which operates on the electroplating principle. This device, called a Chronistor, can be used for indicating the total number of hours during which any electrical instrument, appliance or component has been in operation. Current required by the device is provided by the unit being timed. No auxiliary relays or switches are needed. Elapsed time is given as a direct-scale reading.

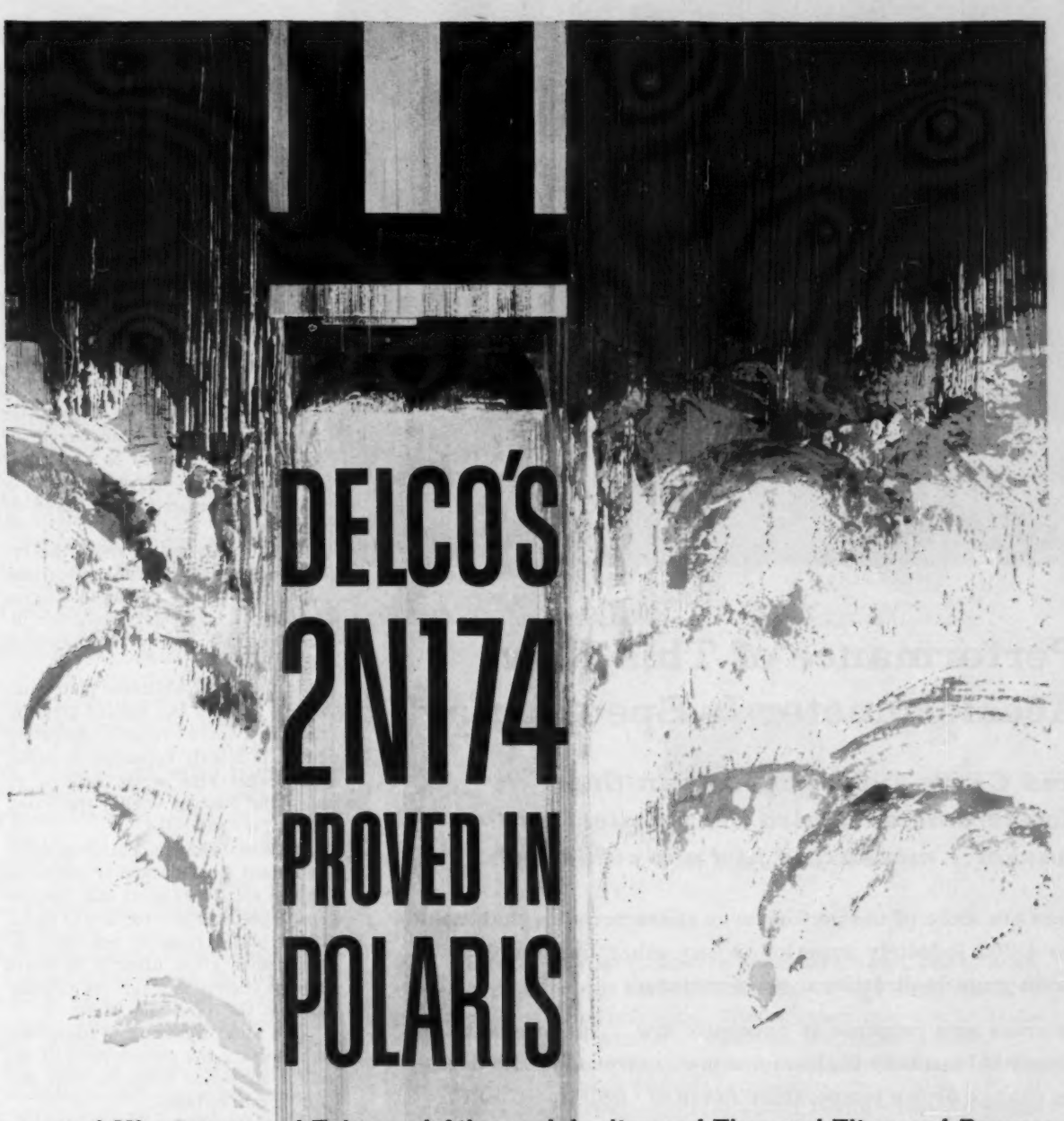
The device is in effect, a miniature electro-plating bath containing anode and cathode electrodes of copper and an electrolyte. The unit is connected in parallel with the device to be timed so that when the d-c voltage is applied, electro-plating proceeds, tending to make the anode shorter and the cathode longer. Where d-c is not available, rectified a-c serves adequately.

By making the dimensions of the electroplating cell small, the current required to transfer copper from one electrode to the other can be made as small as necessary (in fact, proper choice of electrode dimensions is an important consideration in design).

A large value series resistor limits current (and incidentally, serves to maintain a constant current) so that the small variations in the resistance of the electroplating cell are negligible compared to the value of the external resistance.

The cell is a current operating device in that the speed of plating is directly proportional (within limits) to the amount of current passed through the cell. A simple way for maintaining the current constant is to use a series resistor connected to a voltage in the equipment. This resistor will be large compared to the resistance of the time cell and thus maintain a substantially constant current through the cell independent of changes within the cell due to temperature, resistance, time, etc. It is important to keep the voltage applied to the cell substantially constant to achieve the maximum accuracy. Variations of this applied voltage within moderate limits (say ± 10%) have little effect on the overall accuracy of the time measuring cell since they usually tend to average out; that is, higher voltage causes plating to speed up and lower voltage to slow down, with the overall result that accuracies of ±5% can readily be achieved in the timer although the voltage applied to the circuit may vary as much as ± 10% or ± 15%.

Chronistor electroplating cells are usually used by connecting the cell and its associated resistor in parallel with the electrical device whose operating time is to be measured. Thus if it is desired to know how



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long a battery has been in operation, the cell would be mounted across the power input terminals of the battery load (after the power ON-OFF switch). This way, whenever the switch is turned ON, voltage is applied to the cell and its resistor, and time begins to be clocked.

It is also possible to utilize the elapsed-time indicator within an equipment to measure the operating time of a component that is used only intermittently. For example, in a transmitter tube while the power applied to entire transmitter may be on almost continuously, the plate voltage applied to the power tubes may be on only intermittently when the transmitter is keyed or modulated.

If it is needed to know the operating time of the transmitter tube alone, the device can be connected through a large series resistor directly to the plate of the transmitter tube.

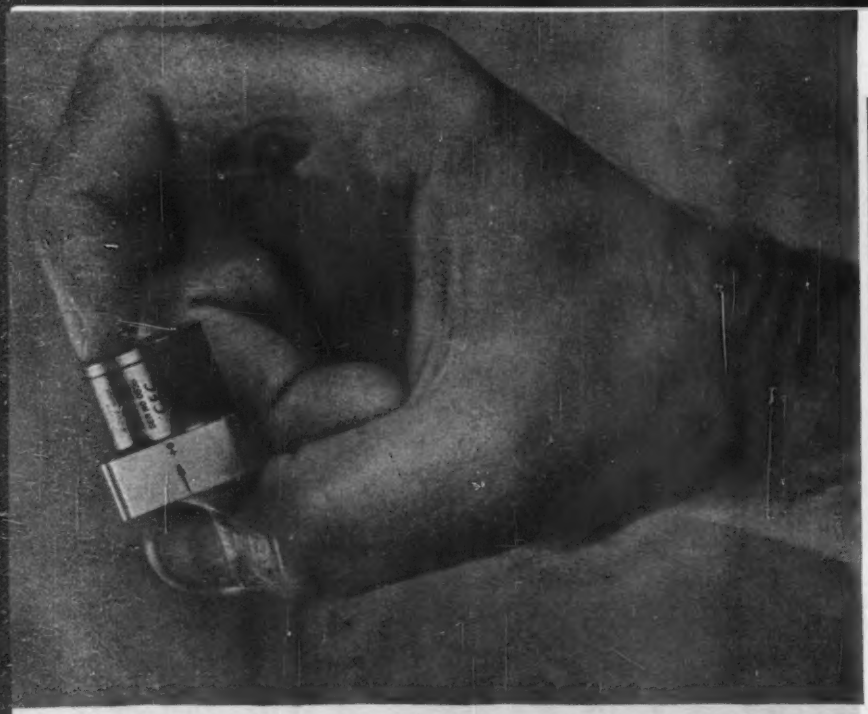
In this way, whenever plate voltage is applied, the elapsed time indicator would record operating time. It is only necessary to select the proper size series resistor to keep the current within the rated value for that cell.

The actual time indication is given by a fixed scale marked or engraved on the electrochemical cell. As the anode becomes shorter due to metal being plated from it, the time indication is given directly in hours by this change in length by reading against the fixed time scale.

The rate of plating is controlled by selecting the proper value of resistor in series with the unit for any given voltage.

A single unit can therefore be used for measuring a wide range of operating times, merely by changing the scale and adjusting the current which flows through the cell.

Data taken on one variety of elapsed time indicator shows that the rate of plating as a function of the current passing through the cell is linear, permitting cells ranging from 100 hours full scale to 10,000 hours full scale to be based on the identical construction. This permits a simple relationship which can be tabulated giving the standard value series resistors for several popularly used d-c voltages.



Performance of This New Accelerometer Is Spectacular!

And CEC's Type 4-202 Strain Gage Accelerometer is also the smallest on the market...measuring just one cubic inch.

Here are some of the performance characteristics that make the 4-202 infinitely superior to any other linear unbonded strain gage bi-directional accelerometer:

Its cross axis response is unusually low...its resonant frequency is unusually high—and there's extremely little damping change over a temperature range of −65°F to +250°F.

The 4-202 is the smallest temperature compensated instrument you'll find anywhere for measuring accelerations perpendicular to mounting surfaces. It's available now in a range of ±5g to ±500g.

For more information, write for Bulletin CEC 4202-X5.

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CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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The technical specifications of the elapsed-time indicator are as follows:

Size: 1.25 *in.* × 0.25 *in. dia.*
Weight: 0.2 *ounces.*
Mounting: standard 3AG *fuse clip holder.*
Operating Time: 100, 250, 500, 1000, 2000, 5000, 10,000 *hours full scale.*
Temperature (operating and storage): 0 *C to* +65 *C.*
*Operating Position: Vertical with anode up (*2,000, 5,000, 10,000 *hour units may be operated in any position).*

As can be seen, the temperature range of operation restricts the use of the timer to commercial or indoor military environments, since the problem of electroplating at sub-zero temperatures has not yet been fully solved.

However, the use of organic and non-acqueous electrolytes have permitted the development of experimental units which operated for as long as 1,000 hours at −55 C and fully developed and tested marketable timers for the full range of temperatures from −55 C to +85 C should be available the first quarter of next year.

The greatest area of use for the elapsed-time indicator has been the determination of time-to-failure of electrical and electronic components and subassemblies and also as a means of periodic servicing of instruments and equipment and warranty of components.

For some of these applications a convenient unit operating from a-c is required and a small package with rectifier, dropping resistor and filter condenser called the Chronistat has been developed by Bergen Laboratories.

However, a myriad of other uses have occurred to designers including a long time delay relay (A loaded micro type switch is tripped when a plunger rod extending into a hole in the anode is exposed by the anode surface receding as plating takes place), d-c current integrators, circuit time constants of the order of days and weeks, battery charger timers, phonograph needle timers, remaining life indicators and many others.

CEC makes them precise...

Type 4-312A Pressure Transducer

Type 4-313A Pressure Transducer

Versatility makes them popular

4-001 Closed-line Adapter

4-008 Chamber-type Adapter

For adaptability in pressure measurement, there's no equal to the pair of unbonded strain-gage instruments pictured here actual size. With adapters they can be flush-mounted... chamber-mounted... water-cooled... water-proofed.

A workhorse with a thousand uses, Type 4-313A is available in absolute and gage models that measure pressures from 100 to 5000 psi in a temperature range of −100°F. to +300°F.—with superior performance in shock and vibration environments. The unit mates with a 4-008 chamber-type adapter as well as with an adapter for use in closed-line pressure measurements.

Type 4-312A, available in absolute, gage and differential models, is a general purpose transducer particularly suited to aerodynamic pressure studies. It operates in a range of 10 to 150 psi in gage, absolute and unidirectional models and from ±5 to ±50 psi in differential models. Used with a 4-001 adapter, it is ideal for closed-line applications.

Call or write for complete information. Ask for Bulletin CEC 1541-X4, Type 4-313A; Bulletin CEC 1540-X4, Type 4-312A; Bulletin CEC 1558-X4, Adapters.

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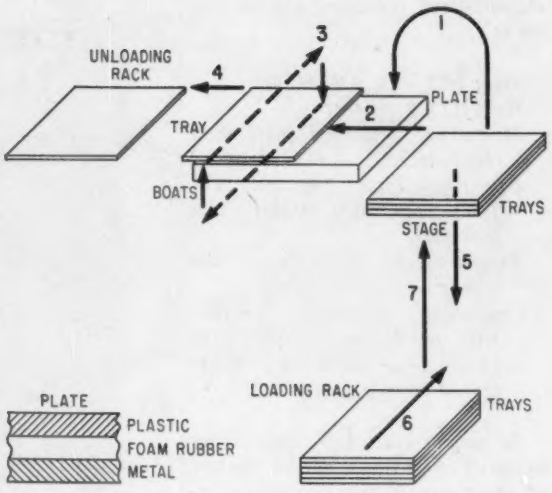
Operator places stack of parts trays on loading rack



Relative position of parts and sequence of operations.

Loading Trays Feed Tube Assembler

COMPARTMENTED TRAYS are frequently used to transport parts unsuited to bulk handling. If the parts are slated for mechanized assembly, a method of rapidly feeding the parts from the trays is desirable.

Automatic tray feeders have been developed for the Automount receiving tube cage assembly machines used by Sylvania Electric Products, Inc., at its plants in Emporium, Brookville, Millhall and Altoona, Pa. and Shawnee, Okla. Much of the equipment which prepares parts for the Automount is designed to automatically load the supply trays.

The feeders supply Automount insertion heads with cathodes and grids, which were formerly handfed (ELECTRONICS, p 118, Nov. 21, 1958). Mechanical grasping is confined to the trays; the parts remain oriented and are subjected only to small turning, sliding and dropping motions against smooth surfaces.

Steps in the feeders' operation are shown in the sketch by the heavy, numbered arrows. Since cathode and grid feeders are basically the same, only the cathode feeder will be described.

The cathodes, previously coated, are brought to the feeder's loading rack in molded plastic trays. A typical tray carries 160 cathodes (20 rows of eight), each in a recess. The recesses have sides which slope down to a small hole, to facilitate cleaning after each use.

As the first arrow of the sketch indicates, a full tray is transferred from the stage to the plate through a 180-degree arc. This is done by having the plate flip over onto the tray. Clamps grasp the edges of the tray and the plate flips back into position. The foam rubber backing of the plate absorbs any shock. The plate is cycled by a motor timed to operate after 160 cycles of the assembly machine.

Second, a rod, operated by an air solenoid, pushes the tray a distance of one row of recesses. The eight cathodes in that row drop off the plate into a waiting line of eight small brass boats. The pusher rod operates once in eight cycles of the machine.

Third, the line of boats is pushed toward the insertion head. The

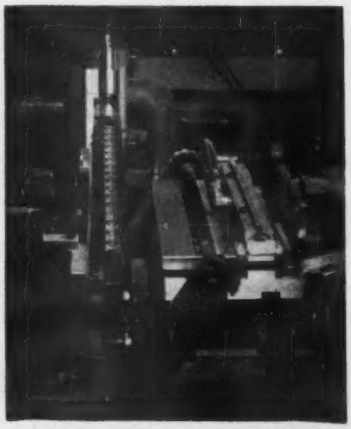


Plate in position to flip tray. Boats are in center and unloading rack at upper left

Plate flipping tray (blur). White cathodes can be seen in recesses of top tray on stage

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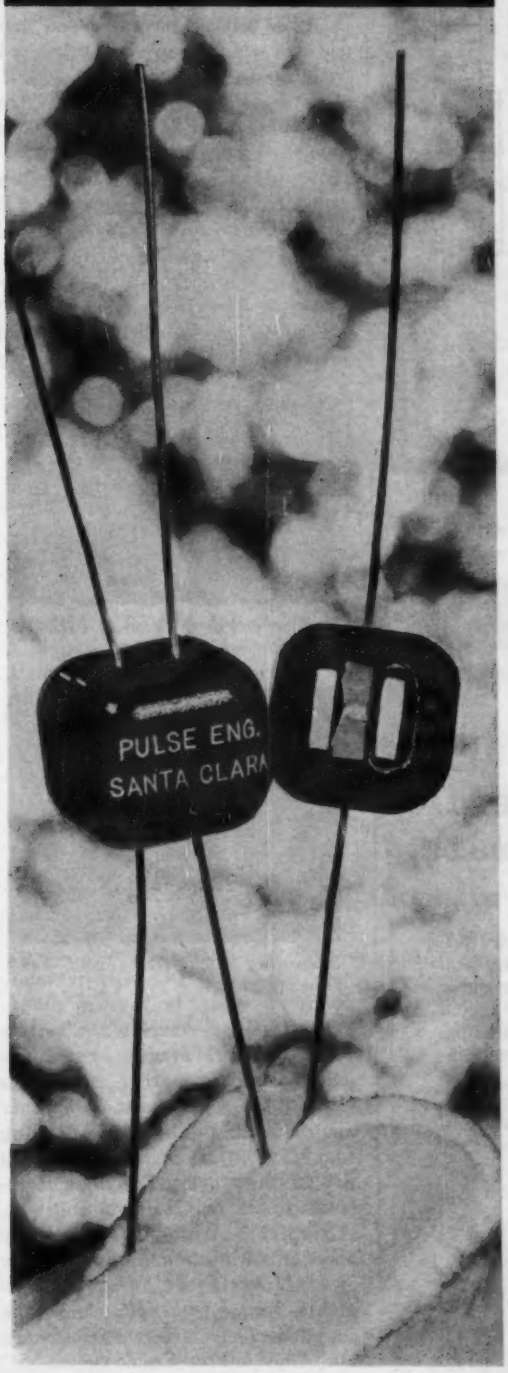
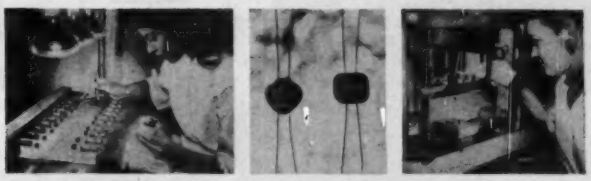
BOOSTS PRODUCTION OVER 420%

Greater product uniformity... better part performance... 70% less labor–with American-Marietta's new EMC epoxy compounds, says leading magnetic component manufacturer.





Previous methods involved costly hand application of layers of resin material. New EMC transfer molding process guarantees a moisture-proof, uniform high density epoxy package. New product appearance is graphically compared by EMC molded part shown at center right with former version.

Again EMC clearly proves its superiority under rigid MIL Spec test requirements. Improved resistance to moisture and temperature cycling as well as standardized part size and shape are some of the important reasons why Pulse Engineering of Santa Clara, California, switched to EMC transfer molding. As a result, output of miniature pulse transformers jumped from 130 to 550 parts per worker per shift, a gain of over 420%, relates Hugh B. Fleming, Pulse President, who intends further expansion utilizing the versatile, reliable properties of EMC.

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Single component dry granular systems, they offer an exceptional balance of electrical, chemical and physical properties. Long range research and extensive military and industrial evaluation continue to demonstrate the reliability and design compatability of American-Marietta's new EMC systems.

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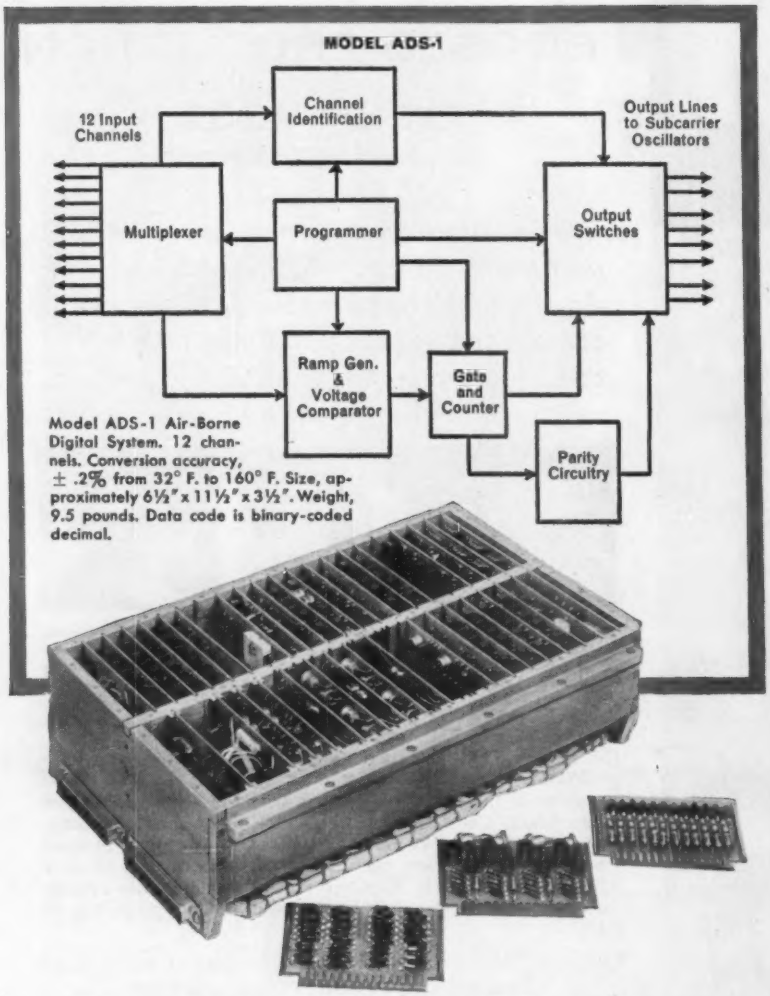
DIGITAL DATA SYSTEMS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Model ADS-1 Air-Borne Digital System. 12 channels. Conversion accuracy, ± .2% from 32° F. to 160° F. Size, approximately 6½" x 11½" x 3½". Weight, 9.5 pounds. Data code is binary-coded decimal.

An air-borne digital system that is small, rugged, accurate, low in cost

Typical of Curtiss-Wright digital systems is Model ADS-1, designed primarily for missile use. It converts multiplexed analog voltages to a digital equivalent for use with FM-FM Telemetry Systems, magnetic or paper tape recorders. System includes input multiplexing, an analog to digital converter, output switching, channel identification and parity checking. Composed entirely of solid state components, except for 12 electromechanical input switching relays. Ideal also for ground instrumentation, industrial quality control, development laboratories. Special systems custom-designed to meet your specific requirements. Blueprint your problem and let us suggest an answer.

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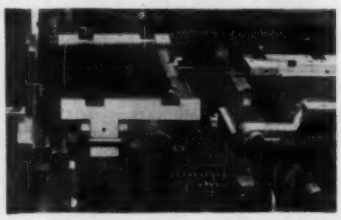
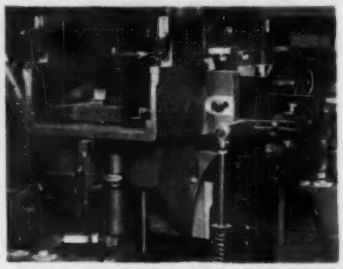
boats slide freely in a track and are not linked. As each boat reaches the end of the track, it tips, dropping a cathode into an escapement. The boat lands on a lower track, helped back to a horizontal position by a small Teflon-tipped knocker. The boat goes to the end of the track and is raised to the top track again. The spring-loaded pushers at the end of each track, and the knocker, are cam-actuated in unison with the machine.

After 8 boats have dropped their cathodes, a line of empty boats is waiting for the next row of cathodes to drop from the tray. After all the cathodes have been unloaded from a tray, the tray transfers (4) to an unloading rack. Rack height is controlled so it is positioned to meet the empty tray. Steps 1 through 4 are then repeated.

Fifth, when the stage is empty, a switch is released. The switch operates an air cylinder which lowers the stage via a chain drive.



Pusher rod drops row of cathodes into waiting boats



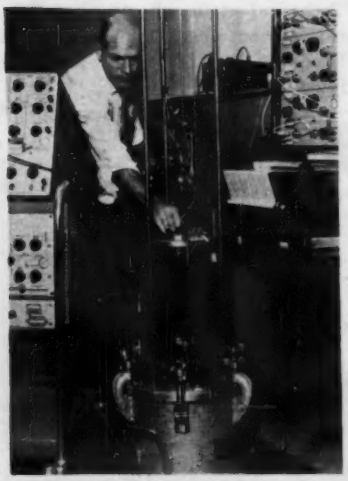
Unloading rack (left) and boat drive (right)

When the stage reaches the bottom of its support frame, behind the loading rack, another switch is tripped. This switch causes another air cylinder to draw the loading rack back (6) so that the stage will lift off the stack of trays as it returns to its original position (7).

Since the Automount's rate is about 1,800 an hour, a load of five or six trays every 15 or 20 minutes is ample to keep the machine supplied. There are two safeguards

against tube mounts being assembled should the supply become exhausted. The operator on the next station observes whether the feeder is loaded. The machine's last two stations are equipped to detect the presence of cathodes and to sound an alarm if they are missing.

Air Pressure Drives Piston to Shock Test



Accelerometer is connected to shock table

PNEUMATIC SHOCK tester produces a short duration pulse which has square wave characteristics and applies constant acceleration for a fixed time. It was designed by Convair Astronautics Division, General Dynamics Corp., San Diego, Calif., to test trimmer potentiometers and is also being used on other shock-sensitive missile components.

The shock table is activated by a pressure pot with a piston drive. The piston is restrained mechanically. When released, it pushes against the bottom of the shock table, generating the desired shock. After initial acceleration, the shock table coasts to a stop on vertical rails.

The g level is calculated by multiplying the area of the piston by the pressure and dividing the product by the weight of the shock table plus its specimen. The pressure chamber will withstand 75 psi. The tester has been calibrated to yield a 50-g load for 11 milliseconds, 100-g for 7 msec, or 500-g for 1 msec. The g-level is monitored by an accelerometer on the shock table.

Gives you accurate, continuously variable voltage outputs

0 to 10 v RMS, 1000 cps
0 to 10 v PEAK to PEAK, 1000 cps
0 to 10 v DC

Especially useful for checking accuracy of laboratory voltmeters and oscillographs

Ballantine's Model 420 Calibrator has proven to be an extremely useful instrument for quickly checking the calibration accuracy of voltmeters and oscillographs.

Its long term stability is such that you can rely on it for better than ¼% when using it with a calibration chart, and ½% without the chart. Accuracy checks can be made with it in less than a minute. This will help you to reduce materially the out-of-service time for voltmeters that otherwise might have to be sent to a central calibration department.

BALLANTINE MODEL 420–AC-DC CALIBRATOR

Price: $365

SPECIFICATIONS

Internal Impedance of Outputs: 2 to 20 ohms over range 0 to 10 v, 1000 cps output; less than 5000 ohms on dc output.

Distortion and Hum: Less than 0.25%.

Setting Resolution: Approaches 0.01% above 10 mv.

Power Supply: 115 v, 50-60 cps, 35 watts; 230 v, 50-60 cps on request.

Dimensions: 6" h, 6¾" w, 10⅞" d.

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CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS, REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC/DC AND DC/AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND AF AMPLIFIER, DIRECT-READING CAPACITANCE METER, OTHER ACCESSORIES.

New On The Market

Low Cost Transistor

HI-FI- AUDIO POWER

TRANSISTOR that makes possible all-transistor high-fidelity sound equipment on an economical basis has been announced by the Radio Corporation of America, Somerville, New Jersey.

The transistor, now being sampled to the home instrument industry, is expected to sell for less than two dollars and to be available early next year.

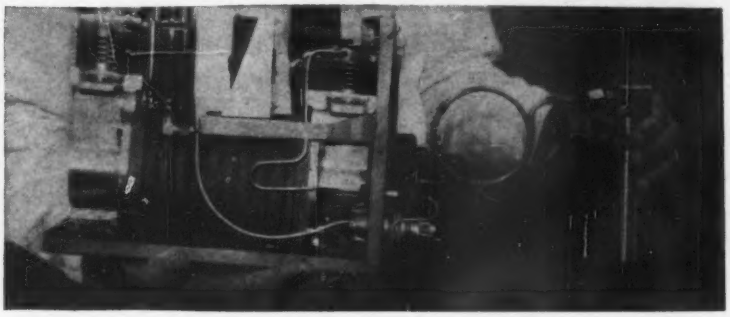
Drift-field power transistor can deliver high audio power for monophonic and stereo sound equipment when operated from either a car battery or house current.

Coupled with the recent price cut of up to 34 percent in the drift-field family, the transistor makes it economical to transistorize high-fidelity and public-address systems, high quality auto radios, jukeboxes and commercial intercoms.

A *pnp*, germanium type, the transistor can be used in both class A and B audio amplifiers. It has an alloyed emitter, diffused collector and graded base and is produced by one inexpensive manufacturing process and one moderately so.

A modified version is also being sampled to the industrial-electronics market.

CIRCLE 301 ON READER SERVICE CARD



Cryogenic System

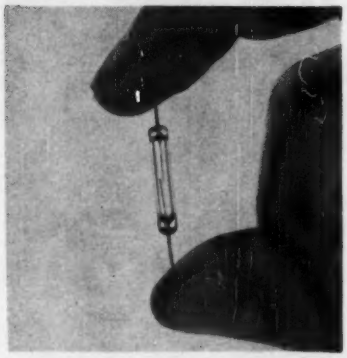
COOLS TO 80 K

SELF-CONTAINED miniature cryogenic electronic cooling system is now commercially available. The closed cycle system uses nitrogen to provide one watt of refrigeration at 80 degrees K (−316 F).

The unit consists of a compressor with an adsorber filter and a remote refrigerating element that is connected to the compressor by flexible lines. The compressor and refrigerating element may be separated by a specified distance.

This system does not require a gas or liquid supply and is designed to run continuously for 500 hours between maintenance. Both a 400-cps, 208-volt, 3-phase unit for airborne use and a 60-cycle, 115-volt, single-phase unit are available. The entire system weighs 16 pounds. Technical data sheets describing this system are available from Air Products, P. O. Box 538, Allentown, Pa.

CIRCLE 302 ON READER SERVICE CARD



Miniature Magnetic Reed

GOVERNMENT END-USE

AVAILABILITY of a miniature magnetic reed contact set for military applications is announced by Defense Activities div. of the Western Electric Co., 195 Broadway, N. Y. Designed by Bell Telephone Laboratories, the GA-53738 L1 magnetic reed contact set, previously known as the BTL-G29 switch, is a miniaturized version of the No. 224A dry-reed switch widely used in the Bell System.

The unit, designed to meet rigorous military requirements, is composed of two overlapping magnetic reeds sealed in a glass envelope $\frac{7}{8}$ inch long. In a standardized test coil the average contact set will close at 34 ampere turns and release at 18 ampere turns.

Initial contact resistance is 0.2 ohm maximum at 0.1 ampere in 1.5-volt circuit. Resistance load rating is 0.125 ampere maximum in 28-volt circuit. Life expectancy is 3 million operations to the 1-percent failure point at maximum load. Overall length is 1.53 inches with

CLECOMATIC

the automatic torque control tools that made industry stop, look and examine their methods of setting screws, nuts, and bolts.

Clecomatic No. 10 Series Screwdriver- Nut-Runner

Clecomatic Right Angle Nut-Runner

Clecomatic No. 10 Series Screwdriver—Nut-Runner: These are the tools that enable you to set torque to the most critical specifications . . . then forget it. Torque is positively maintained by a no-drift locking device. A long wearing, non-friction clutch is quickly adjusted when torque change is desired. *This is the only torque control air tool that starts and stops automatically!* Operator merely engages the screw with bit, the tool starts. When torque is reached, the tool stops. Motor operates only during rundown. Less air is used. Wear is reduced. There is no quality let-down at the end of a shift because control is in the tool. This tool has little impact, is shorter, and weighs less than competitive tools. No. 10 Clecomatic Screwdriver—Nut-Runners are available in pistol grip or straight handles in speeds from 400 to 2,900 r.p.m. Reversible or non-reversible.

Clecomatic Right Angle Nut-Runners: You get uniform tightness in every nut or bolt rundown with a Clecomatic 14 or 16 Series Nut-Runner. Torque is preset. When specified foot pounds are reached, air is automatically shut-off at the driving spindle. The hazardous, tiring torque kick usually found in tools of this type is substantially reduced, your operators can produce more without extra effort. As for maintenance, there's practically none. Cleco's non-friction clutch operates for very long periods, completely maintenance free. Torque adjustment is made externally, no need to disassemble the tool. Clecomatic Nut-Runners are available with both recessed socket heads and double-end spindles (reversible). Speeds range from 250 to 1,000 r.p.m.

NOW AVAILABLE! Clecomatic No. 6 Series Screwdriver—Nut-Runners: Essentially the same tool as the Clecomatic No. 10 Series—but smaller and lighter. No. 6 Series is equipped with the same unique torque control principle. The same automatic start and stop mechanism. They enable you to make even greater cost savings in the production line operations of automotive, aircraft, appliance, and electronic industries. Clecomatic No. 6 Series Screwdriver—Nut-Runners are available for delivery.

To find out how big an improvement a Clecomatic can make in your operation, call your local Cleco® representative for a tryout-demonstration. For detailed literature, write:

CLECO
AIR TOOLS

A Division of REED ROLLER BIT COMPANY
P. O. BOX 2119 • HOUSTON 1, TEXAS
IN CANADA: Cleco Pneumatic Tool Company of Canada, Ltd.
927 Millwood Road, Leaside (Toronto), Ontario

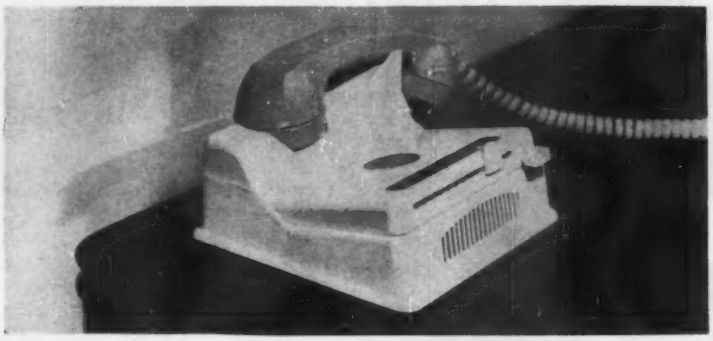
*Trademark

CIRCLE 107 ON READER SERVICE CARD 107

a maximum diameter of 0.16 inch.

Small size, increased sensitivity and speed of operation, provide operation at power levels compatible with other modern electronic devices The units are available only to agencies of the U. S. Government and their contractors for government end-use.

CIRCLE 303 ON READER SERVICE CARD



Telephone Amplifier

BATTERY OPERATED

CALLED Speak-Up, one-piece transistorized unit amplifies a telephone conversation so that the user does not need to hold the receiver to his ear, or to speak directly into the mouthpiece.

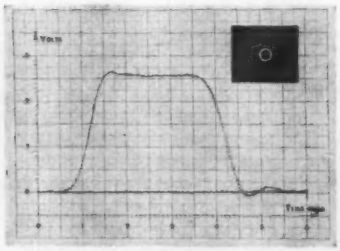
When a call is received or placed, the phone user cradles his telephone receiver on the device, and can talk and hear 10 or 20 feet from the telephone.

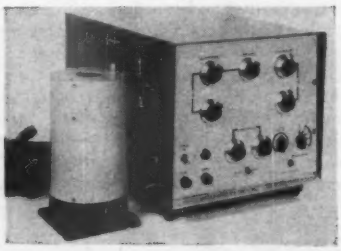
The device requires no installation or wiring, and involves no extra phone bill charges. Fully transistorized, the amplifier works electronically, as soon as the phone receiver is placed on it, and switches off automatically when the receiver is removed. Power is from a 9-volt battery that will last for a year or more in normal use.

Approximately seven inches square and four inches high, it weighs less than 24 ounces and can be carried and used immediately with any telephone.

Feed back is eliminated by locating the telephone microphone four inches from the device's speaker. The English made amplifier is available from Organ Corporation of America, 59 Hempstead Garden Drive, West Hempstead, N. Y.

CIRCLE 304 ON READER SERVICE CARD





Scope Trace Plotter

GREATER SENSITIVITY

OSCILLOSCOPE trace plotter detects, amplifies and plots trace deflections as small as one micron, and is capable of using time resolutions into the submillimicrosecond region to the limits of the traveling-wave deflection tube.

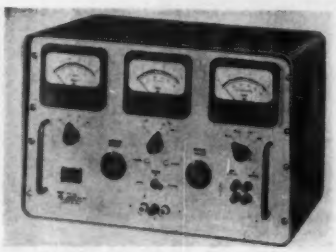
The trace on the face of the twt is reproduced on a prescaled sheet of graph paper so that the time base and amplitude can be read immediately. Almost any X-Y recorder may be used. Sensitivity of the trace is increased about 15 times. The X and Y axis settings are independent of each other and magnification of the axes is arbitrarily adjustable.

Traces of extremely high resolution are reproduced and little accuracy is lost in converting the pulse from the crt to electrical X-Y analogs. Sensitivity of 60 millivolts per trace width on the tube is increased to 4 millivolts per trace width on the plot, a magnification of 15 times. Any section of a trace may be scanned and magnified to obtain full scale recorder drawings of deflections as small as one micron.

Plug-in modulator construction permits the model 860 plotter to be used with virtually any oscilloscope, requiring only slight modification of the scope. Traces are produced in 1½ to 3 minutes.

The plotter is available from Germeshausen & Grier, Inc., 170 Brookline Avenue, Boston, Mass.

CIRCLE 305 ON READER SERVICE CARD



Rectifier Analyzer

DYNAMIC TESTING

DYNAMIC rectifier analyzer tests any semiconductor rectifier at any combination of ratings from 100 milliamperes to 20 amperes and from 0 to 1,000 volts.

The self-contained analyzer tests rectifiers under actual operating conditions and evaluates heat-sink design. It is suited for incoming and on-line inspection and laboratory use; the model 170 exceeds proposed JEDEC specifications.

Flexibility in testing is made possible by independently adjustable forward current and reverse voltage. The need for bulky external load resistors is eliminated. The analyzer provides measurements of average forward current, reverse voltage, average forward voltage drop and average reverse current.

The unit is 19 × 13 × 16 inches, and weighs 65 lb. Price is $855, with delivery from stock in two

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are creating a climate conducive to significant scientific achievement

"Essentially, this corporation will be people—people of the highest quality. The United States Air Force recognizes that men of great scientific and technical competence can perform at their best only when they can exercise their initiative to the full under leadership which creates the climate for creativity. We expect Aerospace Corporation to provide that kind of environment."

SECRETARY OF THE AIR FORCE

Among those providing their leadership to this new non-profit public service corporation are: Dr. Ivan A. Getting, president; Allen F. Donovan, senior vice president, technical; Jack H. Irving, vice president and general manager, systems research and planning; Edward J. Barlow, vice president and general manager, engineering division; and Dr. Chalmers W. Sherwin, vice president and general manager, laboratories division.

These scientist/administrators are now selecting the scientists and engineers who will achieve the mission of Aerospace Corporation: concentrating the full resources of modern science and technology on rapidly achieving those advances in missile/space systems indispensable to the national security.

The functions of Aerospace Corporation include responsibility for: advanced systems analysis; research and experimentation; initial systems engineering; and general technical supervision of new systems through their critical phases, on behalf of the United States Air Force.

Aerospace Corporation is already engaged in a wide variety of specific systems projects and research programs—offering scientists and engineers the opportunity to exercise their full capabilities, on assignments of unusual scope, within a stimulating environment.

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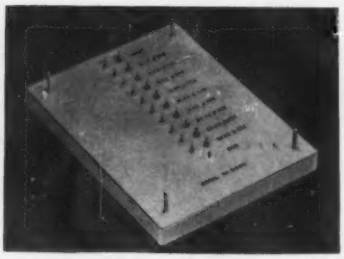
A new and vital force engaged in accelerating the advancement of space science and technology

CIRCLE 378 ON READER SERVICE CARD

CIRCLE 110 ON READER SERVICE CARD→

weeks, from Wallson Associates, Inc., 912-914 Westfield Ave., Elizabeth, N. J.

CIRCLE 306 ON READER SERVICE CARD



Delay Line

10 OUTPUTS

SERIES of magnetostrictive delay lines, type 158, is announced by Deltime Inc., 139 Hoyt St., Mamaroneck, N. Y. The lines are of slab configuration and adaptable to high density packaging of electronic equipment. Dimensions are $7\frac{1}{2} \times 5\frac{1}{2} \times \frac{3}{4}$ inch.

A maximum delay of 39 microseconds with up to nine additional outputs is available. Input pulse width is 0.8 microsecond with a maximum repetition rate of 625 Kc. Insertion loss is approximately 50 db. The signal-to-noise ratio is 20 to 1 and the temperature coefficient of delay is approximately 100 ppm per degree C.

Input and output impedances are 500 ohms.

CIRCLE 307 ON READER SERVICE CARD

Miniature Recorder

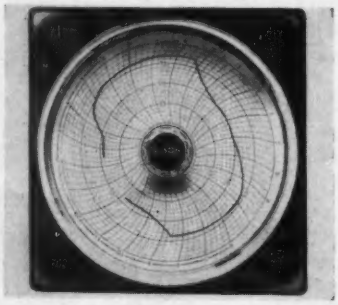
A-C AND D-C SIGNALS

MINIATURE circular chart recorder that will record any variable that can be converted to an electrical signal was announced today by Instrument div., of Thomas A. Edison Industries, McGraw-Edison Co., West Orange, N. J.

Only $3\frac{3}{4} \times 3\frac{3}{4} \times 3$ inches deep, the recorder uses pressure-sensitive paper. A gear shift mechanism provides a three-speed adjustment of chart speed.

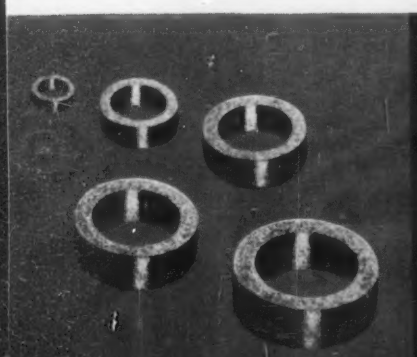
The instrument fills the need for a small inexpensive recorder. It should be particularly useful to manufacturers of laboratory test equipment and portable devices.

The instrument will record electrical voltage, current or power, or any variable such as temperature or



pressure that can be converted to an electrical signal. As in other types of direct-reading instruments, the electrical signal is fed directly to a meter movement, without amplification for signals as low as 10 microamperes. Four basic types of meter movements are available: D'Arsonval, gross coil, moving iron, and

Lockheed Electronics offers complete facilities for



Cores/Memory planes/Stacks

ferrodynamic. Small size permits mounting 9 instruments in one square foot of panel area.

CIRCLE 308 ON READER SERVICE CARD

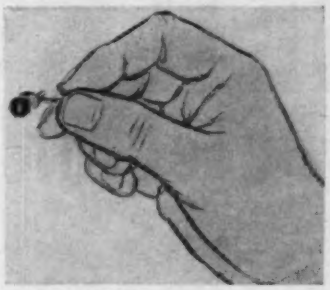
Data System

OPERATES AT 1,500 WPM

A DATA SYSTEM, able to send and receive mass data over telephone lines at high speeds was announced by Digitronics Corporation of Albertson, Long Island, N. Y. Known as the Dial-o-verter System, it functions with the Bell System's Model 200 Data-Phone to transmit information from paper tape, punched cards, or magnetic tape over regular or leased lines. Reception on a high speed tape punch, card punch, or magnetic tape handler is possible. Data can be transmitted in a different medium than received, as when paper tape is used to transmit, and punched cards are produced at the receiving end. Speed of operation up to 150 characters per second is possible. Error checking and error retransmission are options obtained with the system.

The Digitronics Model D 599 SR coupler is the basic component, linking the data media to the Bell System Data-Phone.

CIRCLE 309 ON READER SERVICE CARD



Magnetic Tape Head

MINIATURIZED

THE NORTRONICS CO., INC., 1015 South 6 St., Minneapolis 4, Minn., announces the new J series of miniature record/erase/playback magnetic tape heads. These new heads measure ¼ in. diameter by ¼ in. long, and are well suited for use in miniature tape recorders, motion picture cameras, projectors, industrial equipment, and other applications where size is a problem. Designed for use in transistor circuitry, the heads have a low impedance and excellent frequency response. Track width is 0.070 in. and slow tape speeds can be easily used. Net cost is $23.80 in small quantities.

CIRCLE 310 ON READER SERVICE CARD

Terminals

IN CHAIN FORM

MALCO MFG. CO., 4025 W. Lake St., Chicago 24, Ill. New Tabon terminals for quick connect/disconnect applications are available in chain

One source manufacturing and assembly from cores through memory planes, stacks, and memory systems provide Lockheed Electronics customers with maximum reliability through the entire manufacturing cycle.

LEC manufactures all of its own printed circuit frames and mass-produces any size memory plane and stack to meet varied customer requirements.

This complete control of every facet of manufacture and assembly guarantees you the highest performance and reliability in cores, stacks and memory systems.

Other LEC Ceramic Products for both military and commercial use include Multi-Aperture Ferrite Products, Logic Modules and Recording Heads.

For further information regarding your electronic ceramics requirements, write Dept. C-1, Marketing Department, Lockheed Electronics Company, Avionics and Industrial Products Div., 6201 E. Randolph St., Los Angeles 22, California.

LOCKHEED ELECTRONICS COMPANY LEC

AIRPAX

MAGMETER®
Frequency Detector

The AIRPAX MAGMETER is a frequency detector which produces DC output pulses of constant volt-second area, the average value of the pulses being proportional to the input signal frequency.

MAGMETER output (0-1 ma DC) can be indicated on any readout device capable of responding to average values.

Linearity of better than 0.25% makes its use ideal for powerline frequency measurement, doppler radar and telemetry systems.

Hermetically sealed to operate under severe environmental conditions, MAGMETERS are available with octal-pin bases (illustrated) or rectangular bolt down cases.

Write for bulletin F-25 describing wide range and expanded scale types in the sub-sonic, audio and ultrasonic ranges.

For your applications where failures are not tolerated.

AIRPAX ELECTRONICS INCORPORATED

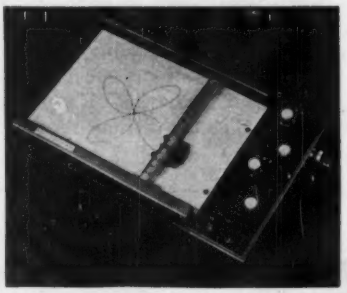
SM32

SEMICOT DIVISION • FORT LAUDERDALE, FLORIDA

112 CIRCLE 112 ON READER SERVICE CARD

form for rapid machine crimping. They eliminate costly hand labor and assure uniform quality. Made with large radii for quick, easy insertion, Tabon terminals feature exclusive vertical and horizontal spring arm action. They are vibration proof and assure constant uniform electrical contact over the full length of the mating areas. The terminals are available in a wide range of wire and insulation sizes, and are of self-wiping and self-cleaning design. The Malcomatic Electro-Crimp machine especially designed for high production use with Malco Tabon terminals is suitable for bench mounting and easily adapted to any production line set-up. Skilled operators are not required.

CIRCLE 316 ON READER SERVICE CARD

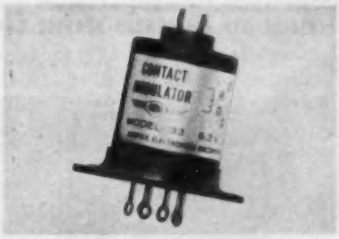


X-Y Recorder
SMALL SIZE

F. L. MOSELEY CO., 409 North Fair Oaks Ave., Pasadena, Calif., has introduced a very compact, lightweight 8½ by 11 in. X-Y recorder. Model 135 features transistorized circuitry and is only slightly larger than the size of the recording paper itself. Dimensions are 10½ in. by 16⅛ in. by 4½ in., and weight is 20 lb. Instrument features built-in calibrated X-axis time sweeps, plus 16 calibrated ranges on each axis, with an infinitely variable vernier. Designed for versatility, the unit may be rack mounted or used on a bench in horizontal, inclined or vertical plane. It also features a detachable carrying handle, which makes the lightweight unit easily portable. Model 135 features high input resistance, a self-contained vacuum paper hold-down, full range calibrated zero set and zero suppression on each axis, plus high recording speed. It is completely compatible for use with a-c/d-c

converter, log converter and other Moseley data handling and recorder accessories.

CIRCLE 317 ON READER SERVICE CARD



Chopper

LOW NOISE UNIT

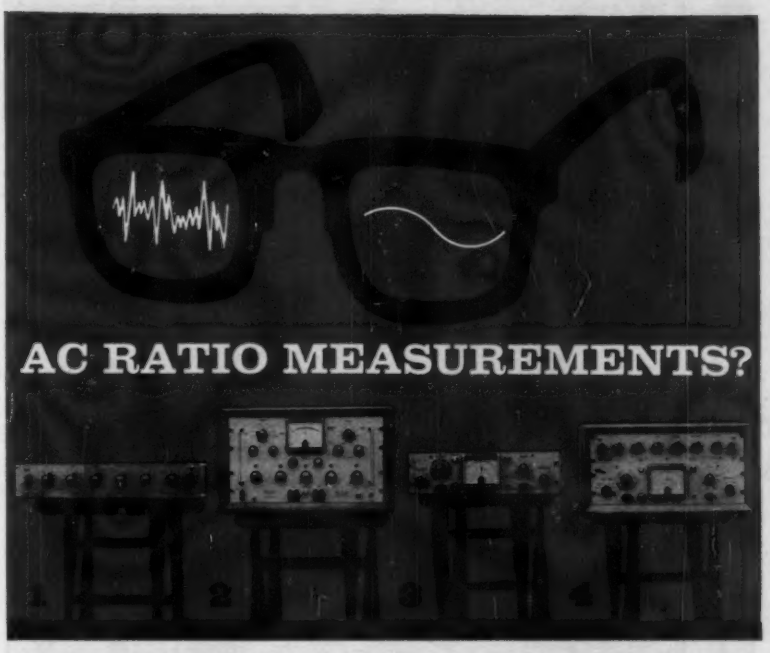
AIRPAX ELECTRONICS INC., Cambridge, Md. Noise levels of 0.6 μv rms (including system noise) are achieved with model 33 electromechanical choppers. Static and magnetic shields, highly confined magnetic fields and exceedingly small air gaps combine to reduce the internal chopper noise to the absolute minimum. Unit is housed in a round metal can with pierced pin terminals. Drive coil leads exit through the top of the can. Model 33 is $\frac{3}{4}$ in. in diameter, has a seated case height of $1\frac{7}{8}$ in. (to top of terminals) and weighs $22\frac{1}{2}$ grams. Drive is 6.3 v at 60 cps; dwell, 175 deg average; phase, 25 $\pm$10 deg; balance, within 15 deg.

CIRCLE 318 ON READER SERVICE CARD

Channel Preamplifier

TRANSISTORIZED

SPENCER-KENNEDY LABORATORIES, INC., 1320 Soldiers Field Road, Boston, Mass., has developed a transistorized, lightweight, miniaturized television and telemetering channel preamplifier in the vhf spectrum. Having a flat response across 6 Mc, the amplifier provides 16 db of gain and has a noise figure of 9 db or less. It is packaged in a weatherproof cylinder; overall dimensions $1\frac{1}{4}$ in. o-d, length including connectors $5\frac{3}{4}$ in.; total weight 10 oz. Primary power is 28



THERE'S A NORTH ATLANTIC INSTRUMENT TO MEET YOUR REQUIREMENTS, TOO...

Now—from North Atlantic—you get the complete answer to AC ratio instrumentation problems—in the laboratory, on the production line, in the field.

Specialists in ratiometry, North Atlantic offers a complete line of precision instruments to handle any ratio measurement task. All are designed to meet the most demanding requirements of missile age electronics—provide high accuracy, flexibility, component compatability and service-proven performance. Some are shown above.

If your project demands total solution to ratio measurement problems, write for Data File No. 10W It provides complete specifications and application data and shows how North Atlantic's unparalleled experience in ratiometry can help you.

NA

1. RATIO BOXES	2. COMPLEX VOLTAGE RATIOMETERS	3. PHASE ANGLE VOLTMETERS	4. RATIO TEST SETS
Both laboratory standards and general duty models. Ratio accuracies to 0.0001%. Operation from 25 cps to 10 kc.	Integrated, single-unit system for applications where phase relations are critical. Accuracy to 0.0001%, unaffected by quadrature. Three frequency operation. Direct reading of phase shift in milliradians or degrees.	Versatile readout system for all ratiometry applications, providing direct reading of phase, null, quadrature, in-phase and total voltage. Broadband, single-, or multiple-frequency operation.	Ratio reference and readout in one convenient package for production line and similar applications. Can be supplied with any desired combination of ratio box and phase angle voltmeter.

NORTH ATLANTIC INDUSTRIES, INC.

TERMINAL DRIVE, PLAINVIEW, L. I., N. Y. • OVerbrook 1-8600

MASSA RECORDERS

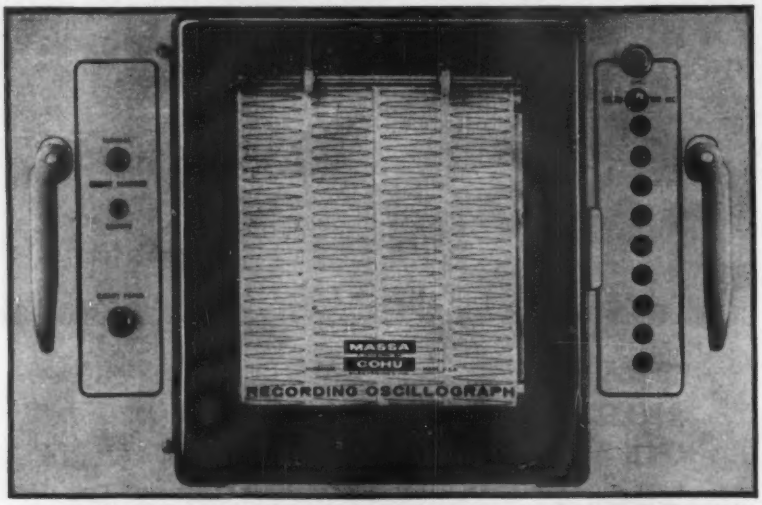
MORE DATA

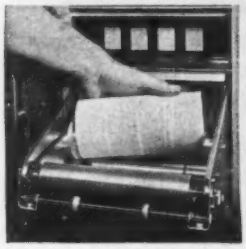
PER DOLLAR

ONLY SOURCE FOR

HIGH SPEED RECTILINEAR INK WRITING

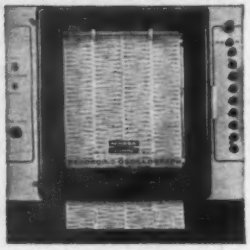
NOW IN 4 CHANNEL — 40 MM





Convenient, instant chart paper reloading from front of recorder.

Easy threading of chart paper to internal take-up roll for data storage.



Alternately, chart paper may feed out from front as shown.

All of the exclusive features incorporated in previous Massa Recorders, including the *New Controlled Linearity Oscillographs*, are incorporated in the NEW 4 CHANNEL RECORDING SYSTEM. The all new front design greatly simplifies chart paper loading and permits full instant view of pen action and recorded signals on 7" x 10" writing table. Improved tracking, instant loading, accurate performance, are some of the novel features included in the new design.

Other features: 40 mm (full scale) Oscillographs, DC to 120 cps • Ink or electric rectilinear writing • 18 chart speeds, from 0.5 cm/hr to 200 mm/sec • Event Marker • Automatic warning light for low chart indicator.

The new 4 channel recorder is now available in complete recording systems including individual transistorized driver amplifiers and power supplies for each channel, and a choice of interchangeable plug-in preamplifiers including DC, AC, Carrier and Chopper.

MASSA
A DIVISION OF
COHU
ELECTRONICS, INC.
6 FOTTLER RD.
HINGHAM, MASSACHUSETTS

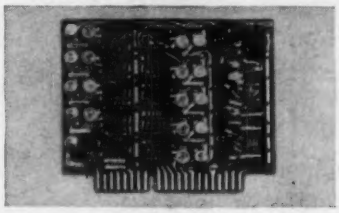
OTHER MASSA PRODUCTS

COMPLETE LINE OF
MULTICHANNEL AND PORTABLE RECORDING SYSTEMS

ACCELEROMETERS
HYDROPHONES
MICROPHONES
AMPLIFIERS
SONAR TRANSDUCERS

v d-c supplied through the output cable. Model 270 is available from stock in all standard tv channels 2 through 13. Quantity inquiries for other bandwidths and at other frequencies from 220 Mc to d-c are invited.

CIRCLE 319 ON READER SERVICE CARD



Circuit Module

TRANSISTORIZED

DATEX CORP., 1307 South Myrtle Ave., Monrovia, Calif. The CM-115 transistorized p-c module, designed for scanning, distributing, or decade counting applications, contains a ten-point counting circuit, input pulse shaper, and reset circuit. The module can be used for counting by decimal decade; alternatively modules may be grouped in series to form a ring counter. Decade counting techniques enable two modules and a toggle to scan 199 points. When combined with "NOR" logic circuit modules, it may be used to sequentially switch up to 199 bits of stored data. Such data may be entered, via suitable amplifiers, into lamp banks, tape punches, and other output devices.

CIRCLE 320 ON READER SERVICE CARD

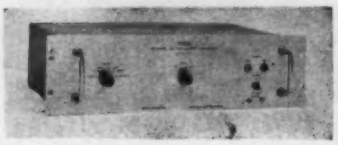
Dust-Tight Relays

TRANSPARENT COVER

OHMITE MFG. CO., 3634 Howard St., Skokie, Ill. Series DOS plastic dust cover relays offer the advantage of visibility permitting observation of

the relay for operation, condition, or position of contacts which is helpful in trouble-shooting or routining associated equipment. All DOS dust-tight relays (metal or plastic covered) have octal plug-terminated bases for instant insertion into matching sockets. The DOS relay is a 2pdt general purpose relay with contact and terminal carrying parts of molded plastic. It is capable of handling loads normally demanded of considerably larger relays (15-ampere contacts). Available for a-c or d-c operation.

CIRCLE 321 ON READER SERVICE CARD



Converter

VOLTAGE TO FREQUENCY

VIDAR CORP., 2296 Mora Drive, Mountain View, Calif. Completely transistorized, the model 250 offers a-c and d-c sensitivities from 0.1 v to 1,000 v and resistance ranges from 1 K to 10 megohms. Accuracy is 0.1 percent for d-c and resistance; 0.5 percent for a-c between 50 cps and 100 Kc. Choice of 0-10 Kc or 0-100 Kc frequency outputs. Range and mode selected manually or by external programmer. Panel is 5¼ in. high and package is 10½ in. deep. There is 90-day delivery at $1,500 to $2,500 depending upon options required.

CIRCLE 322 ON READER SERVICE CARD

Ceramic Magnets

FOR TWT STACKS

D. M. STEWARD MFG. CO., Chattanooga, Tenn. The F-600 ceramic magnets have a coercive force, H_c, of 2,650 oersteds, an intrinsic coercive force, $_iH_c$, of 3,550 oersteds and a residual induction, B_r, of 2,750 gausses. The temperature coefficient of residual induction is −0.18 percent/deg C. Because this material has both a linear demagnetization curve well into the third quadrant and a high intrinsic coercive force, irreversible temperature losses are negligible. Twt stacks employing F-600 magnets ex-

SAUCER FAN

280 CFM

The Saucer Fan represents an entirely new design concept whereby the driving motor is built within the propeller hub limiting its axial length to the minimum measurement required by a highly efficient motor. Ideally suited for tightly packed electronic packages, where space is critical, the Saucer Fan will provide cooling air to the amount of 280 cfm. Power requirement is 115 vac. 50-60 cps, 1 ø.

The fan's pressure performance is tailored to the requirements of a modern, washable dustfilter. "Servo type" mounting flanges at each end of the venturi ring permit simplicity of mounting without loss of space. Direction of airflow may be easily reversed by turning the fan end for end. Electrical connections are made to a compact terminal block.

For complete technical details write to . . .

ROTRON mfg. co., inc.
WOODSTOCK, NEW YORK

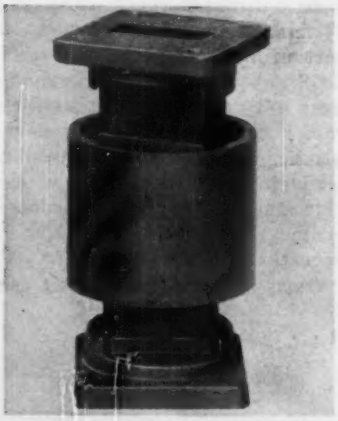
CIRCLE 115 ON READER SERVICE CARD

MANUFACTURING IS PART OF THE RELIABILITY PATTERN AT ELECTRO-TEC

Skilled hands, close attention to manufacturing techniques, quality control and a deep pride in a product well made...all are intrinsic to the reliability pattern at Electro-Tec. In the many stages between design and finished product, these factors are so balanced that desired component reliability becomes a reality every time. This mix of fine craftsmanship and unexcelled manufacturing capability is one of our most valued assets. ELECTRO-TEC CORP. South Hackensack, N. J. — Blacksburg, Va. — Ormond Beach, Fla.

hibit extremely small self-demagnetization effects.

CIRCLE 323 ON READER SERVICE CARD

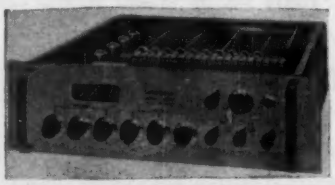


Rotary Joints

TWO WAVEGUIDE SIZES

MICROWAVE DEVELOPMENT LABORATORIES, INC., 92 Broad St., Babson Park 57, Wellesley, Mass., announces two new I-style waveguide rotary joints. Operating in the 8,500 to 9,600 Mc range, they are available in WR90 and WR112 EIA waveguide sizes. Each rotary joint is fully treated before shipment and is accompanied by a written certificate of electrical performance. The joints may be ordered in either aluminum or copper alloy, in a variety of standard finishes. Both non-pressurized and 30-psig pressurized models are available.

CIRCLE 324 ON READER SERVICE CARD



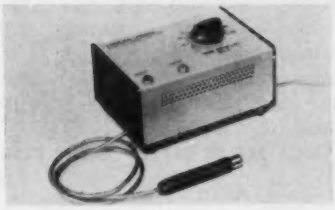
Crossbar Scanner

COMPACT UNIT

JAMES CUNNINGHAM, SON & CO., INC., Rochester 8, N. Y. Model SD-6 crossbar scanner is expected to find wide application in data-processing systems, as a module of computer designs, in automatic process control, in missile test and telemetry equipment, as a sampling device for analog computer outputs, in power or signal distribution centers, in antenna scanners, in digital to analog

conversion, and in the programming of automatic processes and testing devices. Model SD-6L provides a 100-channel, 6-pole-per-channel capacity which can be readily altered to a 200-channel/3-pole, a 300-channel/2-pole, or a 600-channel/1-pole array through a "level-scanning" option.

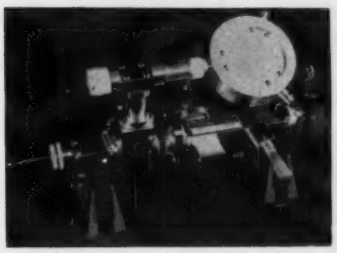
CIRCLE 325 ON READER SERVICE CARD



Component Heater
FOR CIRCUIT ENGINEERS

KENNEDY CO., 2029 N. Lake Ave., Altadena, Calif. Time circuit engineers can now make accurate temperature tests during the breadboard phase using Thermo-Probe, a temperature controlled heater for individual components. A probe about the size of a fountain pen and a control box with a temperature setting control calibrated from 25 C to 150 C comprise the instrument. The probe tip, whose temperature is controlled, fits neatly over a transistor heating it to the desired degree. Tips are readily interchangeable to fit components of different shapes. Temperature calibration is accurate to ±3 C and temperature is maintained closer than ±1 C. Heater power is 6 w. Price is $72.50.

CIRCLE 326 ON READER SERVICE CARD



Parametric Amplifier
FOR S-BAND

MICROMEGA CORP., Venice, Calif., announces the S-band model S1000 parametric amplifier. Typical specifications include a tuning range of 100 Mc, operating gain of 17

DEC BUILDING BLOCK LOGIC KIT

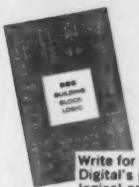
Includes everything needed to perform a wide variety of logical operations

Now Digital offers a basic selection of 500 kilocycle logic circuit packages which can be used to design, test and demonstrate up counters, down counters, four-bit shift registers, decimal decoders, Gray-to-binary decoders, two-binary-digit adders and subtracters, and other similar digital pulse apparatus.

Graphic front panels (a Digital first) permit all logical interconnections to be made quickly and easily by means of handy stacking banana-jack patch cords. And the units can be assembled and reassembled in any number of different combinations in the plug-in mounting panel.

Included in the Basic Kit are nine DEC Digital Test Equipment units — one inverter, one diode nor, four flip-flops, one delay, one clock, and one pulse generator — and the necessary accessory equipment — power supply, power cable, mounting panel, and one hundred patch cords. Other Building Blocks from Digital's fully compatible 500 kilocycle, 5 megacycle and 10 megacycle lines can be added to increase the versatility of this unique new kit.

Complete Kit (FOB Maynard) $1038



Write for your copy of Digital's popular new logical operations handbook — "DEC Building Block Logic"

digital
EQUIPMENT CORPORATION
MAYNARD · MASSACHUSETTS

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CIRCLE 117 ON READER SERVICE CARD

PRODUCT APPLICATION

HANSEN
SYNCHRON
TIMING MOTORS

CLOCK PROGRAMMING
systems

using reset clock movements
powered by Hansen SYNCHRON motors

MINNEAPOLIS-HONEYWELL REGULATOR COMPANY incorporates Hansen SYNCHRON Clock Movements in its Indicating Clocks and Master Control Systems — for installation in schools, public buildings, in industry, or wherever accurate time must be maintained. Single-dial Indicating Clocks are coordinated by Master Clock Programming, with automatic correction — to compensate for deviations caused by current fluctuations — available either on an hourly or 12-hour correction basis. Hourly correction resets the clock which may be from 55 seconds fast to 59 minutes slow depending on current fluctuations, at two minutes before the hour. The 12-hour correction occurs between 5:00 and 5:30 o'clock, automatically resetting clocks up to 12 hours slow.

HANSEN SYNCHRON CLOCK MOVEMENTS were chosen by Minneapolis-Honeywell because of satisfactory power and dependability experienced by a previous supplier to the firm. Hansen SYNCHRON motors are connected to reset movements through a gear, clutch and cam arrangement. The clock systems operate with 60-cycle and 24-volt motors, on 115-volt current — generally most readily available on typical installations.

SEND TODAY for informative folder containing specifications and technical data on all Hansen SYNCHRON motors and clock movements.

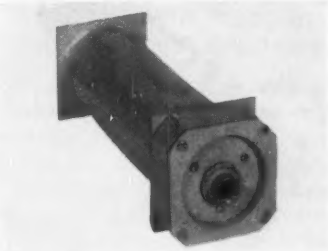
HANSEN MANUFACTURING COMPANY, INC.
PRINCETON, INDIANA

HANSEN REPRESENTATIVES:
THE FROMM COMPANY
5150 W. Madison, Chicago, Illinois
H. C. JOHNSON AGENCIES, INC.
Rochester, N. Y. — Buffalo, N. Y. — Syracuse, N. Y.
Binghamton, N. Y. — Schenectady, N. Y.
ELECTRIC MOTOR ENGINEERING, INC.
Los Angeles, Calif. — (Olive 1-3220)
Oakland, California
WINSLOW ELECTRIC CO.
New York, N.Y. — Essex, Conn. (SOuth 7-8229)
Philadelphia, Penn. Cleveland, Ohio

Sweet's Product Design File

db, bandwidth of 20 Mc (at 3-db points), and a system noise figure of 2.5-3.0 db (operating into a mixer with a noise figure of 10 db). The assembly consists of a three-port ferrite circulator, a reflection-type diode amplifier, a pump klystron, a variable attenuator and a directional coupler monitor. For some applications, ferrite isolators may be necessary between the antenna and the circulator and/or between the circulator and the mixer. Company engineers will custom-design these amplifiers to optimize the electrical characteristics most important for specific systems applications.

CIRCLE 327 ON READER SERVICE CARD



Precision Oven
20 CU IN. CHAMBER

AIRTRONICS, INC., 5522 Dorsey Lane, Washington 16, D. C. Model 1201 precision oven features an internal temperature stability of ±0.01 C at 70 C, over an ambient range of 0 to +50 C. Proportional controller is fully transistorized and powered from 28 v d-c supply. Internal chamber has a volume of 20 cu in. and can be used to house tuning forks, filters, oscillators and other electronic circuitry requiring precision temperature stabilization. Controller can be used with a wide range of oven configurations.

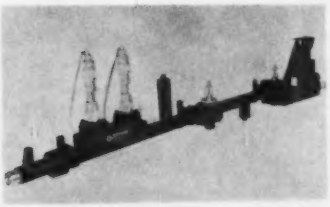
CIRCLE 328 ON READER SERVICE CARD

Sliding Load
WIDE BAND

RADAR DESIGN CORP., Pickard Drive, Syracuse 11, N. Y. Model 1113 is a sliding load for calibrating slotted

lines in the 1,000-8,000 Mc range. Vswr 1.1 maximum (1.05 max at 2,000 Mc and above) is entirely associated with the sliding element. Slide travel is 360 deg (min) at any frequency. Price, dependent on exact quantity; delivery, 5 weeks.

CIRCLE 329 ON READER SERVICE CARD



Monoplexers

COAXIAL LINE

BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass. These microwave components are intended for use in radar systems utilizing separate transmitting and receiving antennas. Typical monoplexer illustrated protects the receiver both from the transmitted signal and from other signals accidentally directed at the receiving antenna. Terminated directional couplers are provided for power monitoring purposes, along with two receiver protector tubes, and an output band pass filter. The unit shown, designed for $\frac{7}{8}$ in. coaxial line, is rated as follows: frequency, 406-450 Mc; transmitter power peak, 30 Kw; transmitter power average 50 w.

CIRCLE 330 ON READER SERVICE CARD

Dual Power Supply

FOR LAB OR FIELD

STRAZA INDUSTRIES, 790 Greenfield Drive, El Cajon, Calif., announces a compact and versatile dual supply for use in the laboratory or field. Two completely independent power sources are contained in the space normally occupied by one similar unit. This results in increased work space and ease of portability. Two meters are provided for voltage setting or continuous monitor-

a new name with a 50 year tradition in electronics

NEMS-CLARKE, a division of Vitro Corporation of America, has produced the finest in precision electronics since 1909. Now, this equipment will be produced and marketed by Vitro Electronics under the Nems-Clarke brand name. In communications, remember Vitro Electronics, the world's foremost designer and producer of special purpose receivers.

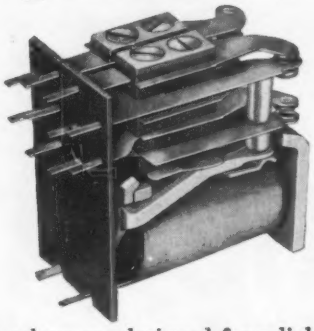
For Free Catalog, Write Dept. R

Vitro ELECTRONICS
A DIVISION OF VITRO CORPORATION OF AMERICA

PRODUCERS OF NEMS-CLARKE EQUIPMENT
919 JESUP-BLAIR DRIVE, SILVER SPRING, MARYLAND • 2301 PONTIUS AVENUE, LOS ANGELES, CALIFORNIA

Now...

A telephone type relay you can plug in and depend on!



Style 5400A

Style 5400A relays are designed for reliable switching in commercial and military printed circuit applications. They are available with contact combinations up to 4 form C and with a wide variety of contact materials for dependable switching of contact loads up to 5 amps.

An insulating board is provided to maintain printed circuit terminal alignment and to protect the relay from mechanical damage. Four tapped holes can be provided in the relay frame for additional mounting support if desired. All relays meet applicable portions of specification MIL-R-5757C.

General Characteristics:

Maximum Coil Resistance: *11,000 ohms*
Sensitivity:
Style 5409A (DPDT) 0.5 watts at pull-in.
Style 5424A (4PDT) 0.8 watts at pull-in.
Contact Combinations: *To 4PDT*
Military Specifications: *MIL-R-5757C*
Dielectric Strength:
1000 VRMS coil and contacts
Operate Time: *15 Milliseconds Maximum*
Release Time: *10 Milliseconds Maximum*
Temperature Range: *Standard construction to 85°C.; special to 125°C.*
Weight: *Approximately 1.7 oz.*

PRICE ELECTRIC RELAYS ARE QUALITY-CONTROLLED

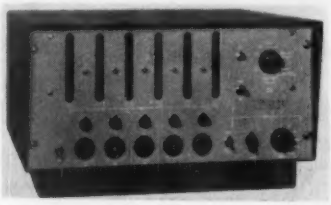
For Additional Information, contact:

PRICE ELECTRIC CORPORATION

306 Church Street • Frederick, Maryland
MOnument 3-5141 • TWX: Fred 565-U

ing of the two output currents simultaneously. The output voltages are continuously adjustable from 5 to 30 v at 0 to 100 ma, with load regulation of 0.2 percent or 20 mv. Line regulation is better than 0.2 percent for line variations from 105 to 125 v. Ripple is less than 1 mv rms. A current limiting feature is incorporated for protection of external as well as internal circuitry. The output may be shorted indefinitely without damage to the unit.

CIRCLE 331 ON READER SERVICE CARD



Computer Scaler

AND EPUT METER

ATOMATION INC., division of C. W. Reed Co., Inc., 5959 S. Hoover St., Los Angeles 44, Calif., announces the Read-O-Matic, an all-electronic computer scaler and events-per-unit time instrument employing medium to long time base intervals. It computes count rate or frequency automatically. Within the wide range of time base settings the computed counting rate or "Quotient" will be displayed with decimal point properly placed. The data is also available for read-out on an associated paper tape printer. Provision is also made for ratio counting in which an unknown count rate may be read out as a percent of a reference or standard count rate. The mode selector switch is used to select the quotient, ratio, preset time, preset count, manual count or scan modes.

CIRCLE 332 ON READER SERVICE CARD

Coaxial Switches

MINIATURIZED

TRANSCO PRODUCTS, INC., 12210 Nebraska Ave., Los Angeles 25, Calif.,

"SPOOLY" SAYS...

Super-Temp

FOR A COMPLETE LINE OF

COAXIAL CABLES

Any high temperature coaxial cable . . . military or commercial . . . Teflon* or polyethylene. You design it, or we'll help you! Either way, you get it faster from Super-Temp.

ALSO: Miniature Cables, Jumbo Cables, Tapes Magnet Wire, Airframe Wire, Hook-up Wire Teflon or Silicone Rubber Insulations

*DUPONT'S TFE RESIN

Save Time WITH **Super-Temp**

American Super-Temperature Wires, Inc.

8 W. Canal Street, Winooski, Vermont • UNiversity 2-9636
General Sales Office: 195 Nassau St., Princeton, N. J. • WAlnut 4-4450
A Subsidiary of Haveg Industries, Inc., Wilmington, Del.

Free! Send for 1960 Catalog. 88 pages of valuable data.

CIRCLE 205 ON READER SERVICE CARD

Going Up!
...higher PRECISION
...higher RELIABILITY

Frequency:
D.C. to 10,000 M
Resistance:
Disc resistors
001 to 400 ohms
Rod resistors
001 to 1500 ohms
Temperature:
-55° C to +150° C
Humidity:
0 to 100% relative humidity

thin

FRI CARBON FILM RESISTORS

- FOR MICROWAVE ATTENUATORS
- PRECISION COAXIAL TERMINATIONS
- DUMMY LOADS • COUPLING LOOPS
- SPECIAL APPLICATIONS

FRI Carbon Film Resistors offer excellent high frequency characteristics and stability plus superior performance under pulse applications. Pyrolytically deposited films on selected substrates are completely protected with special resins. Extremely thin films and lack of spiraling result in minimum inductances. FRI provides tight tolerances (± 1% standard), high reliability and economy in standard or special disc and rod types.

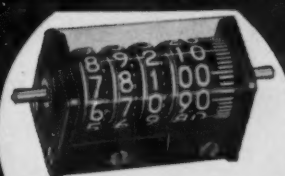
FRI

FILM RESISTORS · INC

242 Ridgedale Ave., Morristown, New Jersey
Telephone: JEfferson 8-2440

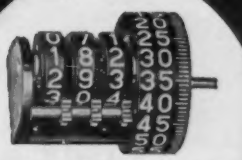
CIRCLE 206 ON READER SERVICE CARD

DURANT
MFG. CO.
Specials
For RADAR, ELECTRONIC and INSTRUMENT APPLICATIONS



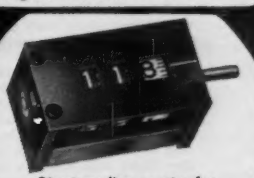
High speed, non-reset, direct reading counter to indicate increment of measurement in radar navigation instruments.

High-speed dual bank counter for use in navigating instruments. Shutter operates to close off either bank when in the minus side.



Counter assembly component of navigating instrument to indicate increments of measurement for fast, legible, direct "read-out".

Special counter for use on Tape Recorder to indicate the position of tape passing through the recorder.



Direct reading counter for navigating and directional instruments. Unit wheel graduations permit reading of 150,000 increments per minute.

Representatives in Principal Cities
WRITE FOR LITERATURE
DURANT MANUFACTURING CO.
1912 N. Buffum St. Milwaukee 1, Wis.
12 Thurbers Ave. Providence 5, R. I.

DURANT
COUNTING INSTRUMENTS

CIRCLE 121 ON READER SERVICE CARD

Lepel

HIGH FREQUENCY INDUCTION HEATING UNITS

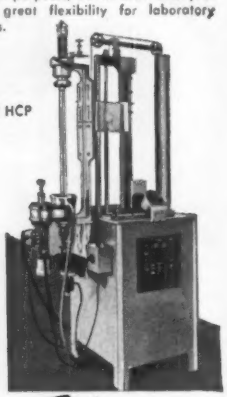
HARDENING · ANNEALING · ZONE REFINING · CRYSTAL GROWING · SOLDERING · BRAZING

Lepel induction heating equipment represents the most advanced thought in the field of electronics... the most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

FLOATING ZONE UNIT FOR METAL REFINING AND CRYSTAL GROWING

A new floating zone fixture for the production of ultra-high purity metals and semi-conductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacumm or inert gas. Designed primarily for production purposes, Model HCP also provides great flexibility for laboratory studies.

Model HCP



Features

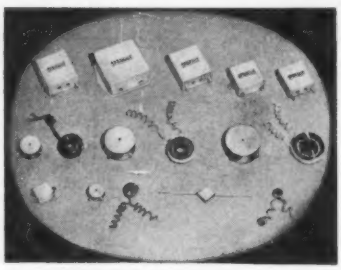
- A smooth, positive mechanical drive system with continuously variable up, down and rotational speeds, all independently controlled.
- An arrangement to rapidly center the process bar within a straight walled quartz tube supported between gas-tight, water-cooled end plates. Placement of the quartz tube is rather simple and adapters can be used to accomodate larger diameter tubes for larger process bars.
- Continuous water cooling for the outside of the quartz tube during operation.
- Assembly and dis-assembly of this system including removal of the completed process bar is simple and rapid.

WRITE FOR NEW LEPEL CATALOG
Electronic Tube Generators from 1 Kw to 100 Kw.
Spark Gap Converters from 2 Kw to 30 Kw.

Lepel HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.
(CHICAGO OFFICE: 6246 W. North Ave.)

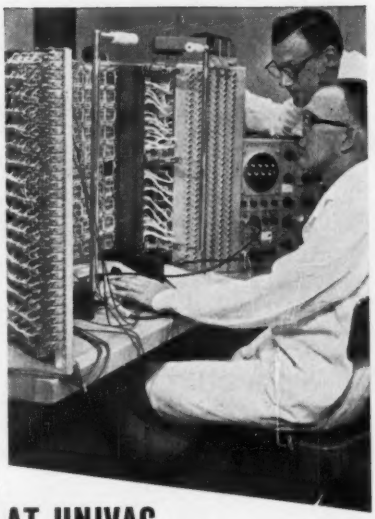
has developed a new line of type W miniature coaxial switches. Line includes spdt and transfer switches which are available with either type N or TNC connectors. Each type uses 28 v d-c solenoids. The spdt is a latching type that requires no holding power. The double throw transfer type has one solenoid and switches from one set of contacts to the other when energized. Typical r-f characteristics at 2,000 Mc are 1.15 vswr, 0.2 db insertion loss, and 50 db crosstalk. Said to be smaller and lighter than comparable switches available, the spdt switch is $\frac{3}{4}$ in. by $2\frac{1}{4}$ in. by $2\frac{1}{4}$ in., 5.5 oz; and the transfer switch is $1\frac{3}{4}$ in. by $1\frac{3}{4}$ in. by $3\frac{1}{4}$ in., 10 oz.

CIRCLE 333 ON READER SERVICE CARD



Toroidal Inductors
CLOSE TOLERANCE

SPRAGUE ELECTRIC CO., Marshall St., North Adams, Mass., announces a new complete series of precision toroidal inductors with close inductance tolerance of ± 1 percent. Line includes such styles as open coil, plastic-dipped, rigid encapsulated inductors with tapped or through-hole mounting, and hermetically-sealed inductors. All styles, with the exception of the open coil type construction, meet the appropriate requirements of MIL-T-27A. Several core permeabilities may be obtained in each of the five basic sizes of Sprague inductors to give the circuit designer the optimum selection of desired Q and current carrying abilities. Each of the core sizes is available with several degrees of stabilization. Inductors made with cores which have not been subjected to the stabilization process exhibit low inductance drift with time and have a low temperature coefficient of inductance. Where a greater degree of permanence of characteristics is required, cores



AT UNIVAC...

OPPORTUNITIES FOR

Transistor Circuit Designers

Immediate openings are now available at Remington Rand Univac for Transistor Circuit Designers, as well as other professional personnel who are seeking a career opportunity.

Investigate these opportunities and make your step toward enjoying the many benefits of a position in Univac's *atmosphere of achievement.*

- **TRANSISTOR CIRCUIT DESIGNERS**

Applicants should have an electrical engineering degree with a minimum of 3 years actual hardware experience in the development of data processing utilizing solid state devices.

Other openings include:

- COMMUNICATIONS ENGINEERS
- SERVO-ENGINEERS
- SYSTEMS ENGINEERS
- MECHANICAL ENGINEERS
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- MILITARY PUBLICATIONS EDITORS
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- QUALITY CONTROL ENGINEERS
- PRODUCTION ENGINEERS
- STANDARDS & SPECIFICATIONS ENGINEERS

Send resume of education and experience to:
R. K. PATTERSON, DEPT. T-12

Remington Rand Univac

DIVISION OF SPERRY RAND CORPORATION
2750 West Seventh St., St. Paul 16, Minn.

There are also immediate openings in all areas of digital computer development at our other laboratories. Inquiries should be addressed to:

F. E. NAGLE, Dept. T-12
REMINGTON RAND UNIVAC
1900 West Allegheny
Philadelphia 29, Pa.

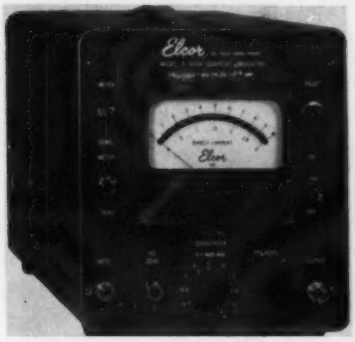
D. CLAVELOUX, Dept. T-12
REMINGTON RAND UNIVAC
Wilson Avenue
South Norwalk, Conn.

CIRCLE 122 ON READER SERVICE CARD

CIRCLE 377 ON READER SERVICE CARD

with two different stabilization treatments can be used for most types of inductors.

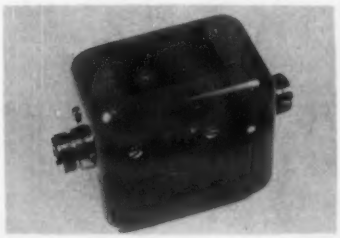
CIRCLE 334 ON READER SERVICE CARD



Current Indicator
WIDE RANGE

ELCOR, INC., Falls Church, Va. Combining high sensitivity and low drift, the model I-309A current indicator is a wide-range current measuring instrument designed for measurement of electron or positive-ion beam current and general laboratory use. Full-scale sensitivity can be varied from 1 ma to 3 na in 12 switch settings. Drift is less than 0.01 percent per hr and overall accuracy is 1 percent of full scale. An auxiliary output is provided to drive a 1 ma recorder. The instrument has a response time of 10 millisec, and can be used as low-drift d-c amplifier as well as a current indicator.

CIRCLE 335 ON READER SERVICE CARD



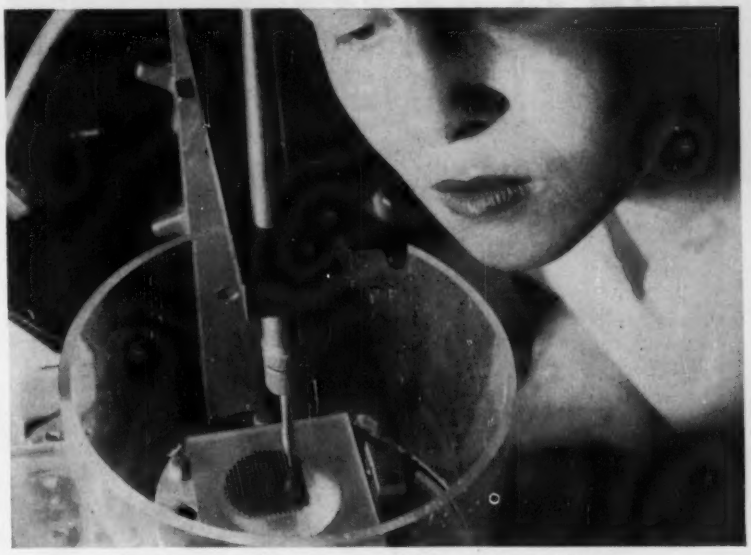
Square Waver
COMPACT UNIT

MELABS, INC., 3300 Hillview Ave., Palo Alto, Calif., has available a new square waver which is used to square wave modulate r-f power in the 500 to 4,000 Mc range. Model X-143 contains a battery-operated transistorized multivibrator which drives a solid state chopper. This method provides square wave modu-

Another "impossible" job done by the Airbrasive®...

...cutting semiconductors

abrading • cutting • deburring • stripping • drilling • cleaning • scribing



Hughes cuts fancy figures in silicon. Reports "Airbrasive is the only tool capable of handling the process!"

Hughes Aircraft uses the Industrial Airbrasive linked to a pantograph to cut intricate patterns and shapes in semiconductor wafers. And what's more they are doing it accurately and with *complete safety to the fragile part.*

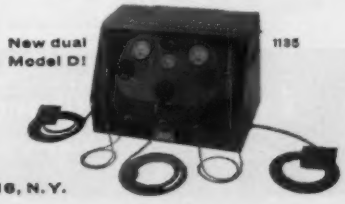
The secret of this unique tool is a superfine jet of abrasive particles and dry gas, directed through a carbide nozzle. The resulting cutting action in hard brittle materials is cool, rapid, precise, and completely shockless.

The Airbrasive is being used to solve hundreds of seemingly impossible jobs... precision deburring... to remove surface deposits ...form and adjust microminiaturized circuits... cut glass, germanium, tungsten, ferrites, and others.

Low in cost too. For under $1,000.00 you can set up your own Airbrasive cutting unit!

Send us samples of your "impossible" jobs and we will test them for you at no cost.

SEND FOR BULLETIN 6006... complete information.



S. S. White
S. S. White Industrial Division
Dept. EU, 10 East 40th Street, New York 16, N.Y.

CIRCLE 123 ON READER SERVICE CARD

NOT A METER...
NOT A MULTIMETER...
BUT...a new type of
INCREMENTAL MULTIMETER!

● An entirely new type of test equipment, the Tensor #5880 Incremental Multimeter enables increments of any of the unit's ranges to be expanded about any point.

These ranges, including attachments, consist of *over 50 different* values of current, voltage, resistance, audio power, temperature and transistor characteristics with typical accuracies of 1.5% D.C. or 2% A.C. Increments as small as .01% can be measured and recorded!

The Tensor Incremental Multimeter may be employed wherever a strip chart recorder is used to display variations in a parameter that may be represented as a voltage, current or resistance capable of being measured on a Simpson "270" multimeter. Typical examples are the study of line voltage variations or power supply regulation.

Servo recorders of various sensitivities from 1 MV to 250 MV can be used. When used with a 5MV sensitivity external servo recorder expansions to ±1% of the full scale of the range are available. The attenuator enables the expansion to be adjusted to any value from 1% to 100%. A D.C. millivoltmeter may also be used if no permanent record is needed.

The Tensor Incremental Multimeter consists of a Simpson "270" multimeter, suppressor power supply, and attenuator. Package dimensions are 18" long, 4⅝" high and 7½" deep. It weighs 7 lbs.

PRICE $250 *DELIVERY FROM STOCK*

tensor ELECTRIC DEVELOPMENT COMPANY, INC.
1873 Eastern Parkway • Brooklyn 33, New York

lation for klystrons and signal generators which is completely f-m free. The modulation frequency of model X-143 may be varied from 800 to 1,200 cps with a convenient control knob. Overall dimensions of the unit, including controls and connectors, are 3½ in. by 2 in. by 2 in. Delivery is 30 to 45 days for limited quantities.

CIRCLE 336 ON READER SERVICE CARD

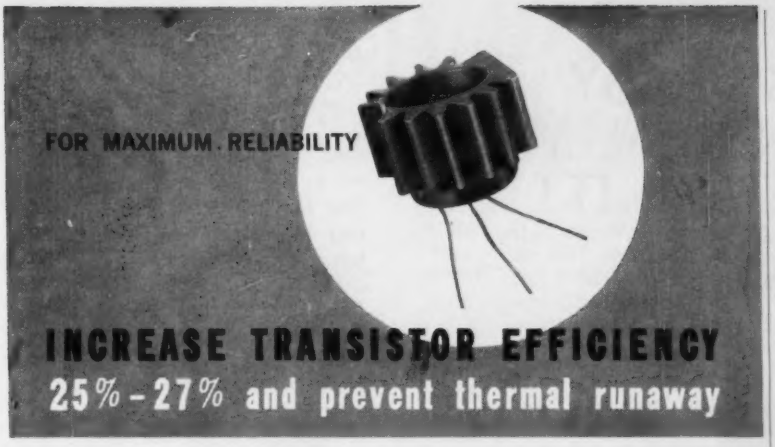
L-F Oscillator
MINIATURE PACKAGE

MONITOR PRODUCTS CO., 815 Fremont, South Pasadena, Calif., announces a new miniature low frequency oscillator designed to withstand extreme vibration and shock and still retain an accurate, miniature package. FS-1001 F is a miniature frequency standard package with these specifications: outside dimensions, 1 in. by 1 in. by 2½ in.; electrical frequency, as low as 8 Kc; stability: ±0.004 percent from 0 C to + 60 C, ±0.019 percent from −55 C to ±70 C, ±0.025 percent from −55 C to +100 C. Figure wave form as square wave, rise and fall time of 10 μsec max, with output voltage of 0 ± 0.5 v to 6 + 3.0, −0.5 v swing. Vibration is 30 g from 20 to 2,000 cps and the shock is 70 g for 11 millisec. Ambient temperature range is −55C to +100 C.

CIRCLE 337 ON READER SERVICE CARD

Regulator Socket
15-AMPERE CONTACTS

AIRBORN CONNFCTORS, INC., 2618 Manana Drive, Dallas, Texas, has



THERE'S A BIRTCHER RADIATOR FOR MOST TRANSISTORS!

Birtcher transistor radiators for most sizes of transistors permit you to get up to 25% to 27% better output efficiency. You can now either increase your input wattage up to 27%, or eliminate up to 27% of the heat with Birtcher radiators.

and thermal runaway is prevented!

To assure circuitry reliability . . . specify Birtcher radiators. Birtcher qualification tests conducted under MIL standards prove these performance results.

FOR CATALOG and TEST REPORTS write: THE BIRTCHER CORPORATION *industrial division*

Sales engineering representatives in principal cities.

745 S. Monterey Pass Rd.
Monterey Park, Calif.
ANgelus 8-8584

CIRCLE 207 ON READER SERVICE CARD

ELECTROLYTIC AND PAPER TUBULAR *CONDENSERS*

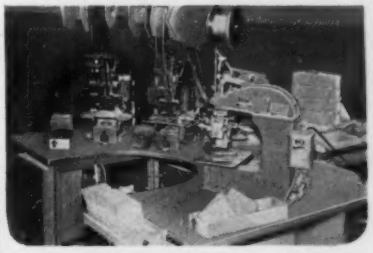
"35 YEARS OF PROVEN DEPENDABILITY"

COSMIC CONDENSER CO.
853 WHITTIER STREET, BRONX, N. Y.
LUdlow 9-3360

CIRCLE 208 ON READER SERVICE CARD

DYNASERT

Speeds Component Inserting to 10 Times in PW Boards



Long or short runs, Dynasert saves. Automatically feeds component, trims, bends leads, inserts, and clinches without damage to component body. Speeds model changeover. Improves board dependability.

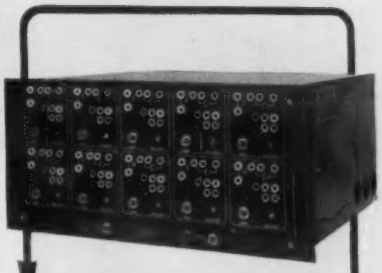
Single or multi-stage units for highly dependable production are available. Write for descriptive 12 page booklet.

United

UNITED SHOE MACHINERY CORPORATION
140 Federal Street, Boston, Mass.

CIRCLE 209 ON READER SERVICE CARD

FROM PHILBRICK:
10 stabilized amplifiers in one supremely versatile manifold!



STABILIZED OPERATIONAL MANIFOLD

MODEL K7-A10

Contains 10 USA-3 Universal Stabilized Amplifiers. A precision instrument of unusual versatility. Permits fast, economical set-up of many instrument or computing configurations. Ideal as a low cost computor, with unusual flexibility as a "simulator" of large scale systems. Also well suited for industrial or production line test equipment applications. Price, $1200

POWER SUPPLY — MODEL R-300

As a power source for the K7-A10, we recommend this 300 ma regulated power supply, because its exceptional regulation and sub-millivolt noise allow it to serve also as a high accuracy reference voltage. Due to its ultra-conservative ratings, the R-300 will allow the K7-A10 to operate indefinitely, even under full load conditions (350 ma). Price, $390

- Available from stock
- Military equivalents available
- Technical data available on request

GEORGE A. PHILBRICK RESEARCHES, INC.
285 Columbus Avenue, Boston 16, Mass.
COmmonwealth 6-5375, TWX: BS1032, FAX: BSN
Representatives in principal cities
Export Office: 135 Liberty Street, New York 6, N. Y.
Tel. WOrth 4-3311, CABLE: TERMRADIO

CIRCLE 125 ON READER SERVICE CARD

THIS "BABY" CAN REALLY TAKE IT!

AMPEX specifies Hill signal generators for use in the AR-200 magnetic tape recorder because of their high reliability under extreme environmental conditions. The compact Hill units generate a precision 60-cycle frequency which is power amplified to operate the recorder's capstan drive motor. While paralleling the qualities of advanced laboratory recorders, the sturdy Ampex AR-200 will withstand shock up to 15 G's, operate at altitudes of 100,000 feet, function under excessive temperature changes and in up to 100% humidity. It displaces only 1.6 cubic feet.

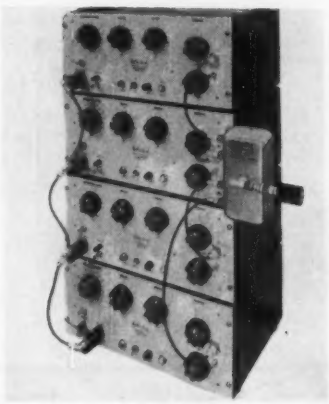
BULLETIN FS 17900
fully describes Hill's Signal Generator used in this application. Write for your copy.

Hill Electronics manufactures precision, crystal controlled frequency sources, filters and other crystal devices for operation under all types and combinations of conditions.

HILL ELECTRONICS, INC.
MECHANICSBURG, PENNSYLVANIA

developed a new, high grade, regulator socket for use with Electric Regulator Corp.'s Size 1 Regohm. New base is molded of long glass-fiber-filled Diallyl type GDI-30 and uses phosphor bronze contacts which are gold over silver plated. The regulator base socket has 15-ampere contacts and withstands a test voltage at sea level of 4,000 v d-c between contacts. Sockets are for 0.093 in. diameter pins. The unit is manufactured to all applicable portions of MIL standard 202A, MIL-E-5272A, and MIL-C-8384A.

CIRCLE 338 ON READER SERVICE CARD



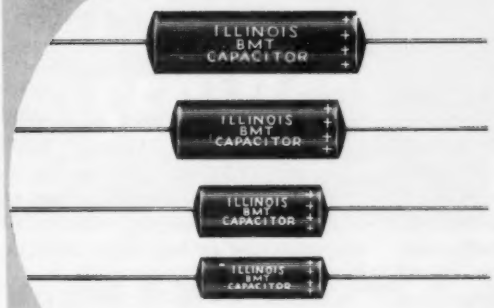
Multipulse System
FOUR UNITS

RUTHERFORD ELECTRONICS CO., 8944 Lindblade St., Culver City, Calif. Operating four models of the B-7B with the use of the mixing network will produce four individual pulses of various specifications. Operating on the same frequency, one of the pulse generators acts as a trigger source for the second, third and fourth units. Except for the repetition rate (to 2 Mc) the delays, widths, output, pulse position, polarity and the rise and fall time are completely independent of each other. Each of the four B-7B models can be disassembled and returned to the laboratories for use as individual pulse generators. Specifications of the B-7B: 50 v amplitude delivered into a 50 ohm load, delay with respect to sync out: 0-10,000 μsec, width: 0.50 μsec—10,000 μsec, repetition rate: 20 cps to 2 Mc. Each model B-7B unit is priced at $720, mixer assembly at $75.

CIRCLE 339 ON READER SERVICE CARD

NEW MINIATURIZED Electrolytic CAPACITORS

Time Tested Quality



TYPE BMT
in Plastic cases
(actual size)

Our high volume production, especially developed for this new BMT line, enables us to offer these small, rugged, dependable, quality electrolytic capacitors priced to fill the needs of low cost, economic designing.

Ideal for transistor applications . . . size ranges diameters 3/16" up to ⅝"; capacity 1 mfd. to 2,000 mfd.; 3 volts to 50 volts; operating temperature range from —30°C to +65°C. Units have low impedance at —30°C and low leakage throughout the entire temperature range.

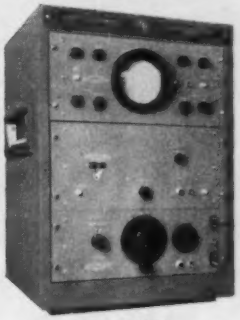
Write for technical information and illustrated literature.

ILLINOIS CONDENSER COMPANY
1616 N. Throop Street Chicago 22, Illinois
Telephone: EVerglade 4-1300

Export:
15 Moore St
New York 4
New York

CIRCLE 210 ON READER SERVICE CARD

TYPE 7000-B AUDIO PRIMARY PHASE STANDARD



FEATURES:

- ±0.05° Phase Shift Accuracy
- 30 cps to 20 kc Frequency Coverage
- 0° to 360° Continuous Phase Shift
- Ultimate Accuracy of ±0.01°
- Self-Calibrating
- Long-Term Operating Reliability
- Lissajous Pattern Presentation

The Type 7000-B Audio Primary Phase Standard supplies two sinusoidal voltage signals whose phase relationship is known to ±0.50° and is continuously variable from 0° to 360°. The frequency of the two signals is the same and is set at one selected frequency from 30 cps to 20 kc.

Specifications

Frequencies: Any single frequency from 30 cps to 20 kc. Frequency is set with an accuracy of ±0.05%.

Accuracy of Phase Angle: ±0.05°. For angles which are multiples of 1°, carefully taken readings are accurate to 0.01°.

Output Voltage Range: 1 to 12 volts (rms).

Output Distortion: Total harmonic distortion less than 0.05%, provided output voltage is within specified range of 1 to 10 volts (rms).

Output Impedance: Approximately 200 ohms (from cathode follower).

Power Supply: 105-125 volts, 50-60 cycle electronic-regulated, self-contained supply, requiring approximately 450 watts.

Physical Specifications

Dimensions: 21¼" wide x 31" high x 21½" deep.

For full details and specifications, wire or call

ACTON LABORATORIES, INC.
A Subsidiary of
TECHNOLOGY INSTRUMENT CORP.
517 MAIN STREET, ACTON, MASS.
COlonial 3-7756

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AT LAST—THE IDEAL BARRIER TERMINAL STRIP

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LONGER—STURDIER

Wider and higher barriers for increased creepage distances. Closed bottoms for complete insulation. Material between barriers at the base adds to the strength and maintains the same creepage distance between contact to contact and contact to ground. Can be imprinted here. No insulating or marker strip required. Three series—540, 541 and 542 having the same terminal spacing as our 140, 141 and 142 series.

Complete listing in the new Jones No. 22 catalog. Write for your copy today.

Jones
HOWARD B. JONES DIVISION
CINCH MANUFACTURING COMPANY
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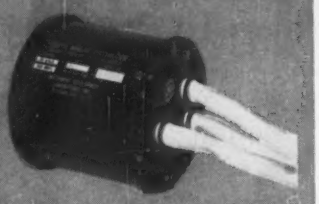
DIVISION OF UNITED-CARR FASTENER CORP.

CIRCLE 212 ON READER SERVICE CARD

Analog to Digital
CONVERTERS



for Linear or
Angular Motions

IDL Shaft Angle Converters

are fully qualified
per MIL-E-5272 A

for Operation:

At temperatures 0°F to 160°F
per Paragraph 4.1.1 Procedure 1
From 0.55 to 14.7 p.s.i.a.
per Paragraph 4.5.3 Procedure 3
Under vibration 5-5000 cps
per Paragraph 4.7.1 Procedure 1

for Exposure:

To Humidity and Temperature
per Paragraph 4.4.4 Procedure 1
To Sand and Dust
per Paragraph 4.11.1 Procedure 1
To 50 hour Salt Spray
per Paragraph 4.6 through 4.6.13
To Shock
per Paragraph 4.15.1 Procedure 1 and Paragraph 4.15.2.1
To 10 G's Sustained Acceleration
per Paragraph 4.16.2 Procedure 2

For Linear Motions, Model 500206 provides accuracies of 1 part in 1000 counts.

For Angular Motions, Model 500406 provides accuracies of one tenth degree; Model 500407 provides accuracies of a tenth of a minute.

Each unit provides bidirectional rotation for applications in mechanically geared systems. The Gray BCD coding system is easily translated into other digital format for visual readout or for recording.

For specifications on these components, ask IDL for their data sheet, "Shaft Position to Digital Converters" or price information, use your letterhead.

INSTRUMENT DEVELOPMENT LABORATORIES
INCORPORATED
Subsidiary of Royal McBee

51 MECHANIC STREET, ATTLEBORO, MASS.

Literature of the Week

R-F TEST EQUIPMENT Telonic Industries, Inc., 60 N. First Ave., Beech Grove, Ind. A 60-page catalog contains complete descriptions of a wide line of r-f sweep generators and other r-f test equipment and components for laboratory and production line applications.

CIRCLE 340 ON READER SERVICE CARD

MICROWAVE FREQUENCY MULTIPLIER Gertsch Products, Inc., 3211 South La Cienega Blvd., Los Angeles 16, Calif. Bulletin FM-4A is a two-page data sheet covering a phase-locked oscillator capable of transferring the accuracy and stability of a vhf driver into the microwave region of 500 to 30,000 Mc.

CIRCLE 341 ON READER SERVICE CARD

SPEED REDUCER Insco Co., Main St., Groton, Mass. A new catalog describes in detail the step-function speed Reductor plus seven individual case studies of new designs based on this patented principle.

CIRCLE 342 ON READER SERVICE CARD

ANECHOIC CHAMBER Emerson & Cuming, Inc., Canton, Mass., announces a new Eccosorb microwave anechoic chamber brochure. Typical specifications have been included for the guide of anyone contemplating purchase of a darkroom.

CIRCLE 343 ON READER SERVICE CARD

SILICON DIODES Sperry Semiconductor Division, Sperry Rand Corp., Norwalk, Conn., has released specification sheets on its new SD series of 250 ma and 400 ma subminiature silicon diodes.

CIRCLE 344 ON READER SERVICE CARD

MOTOR GENERATOR EQUIPMENT American Electronics, Inc., 1598 East Ross Ave., Fullerton, Calif. A new series of product bulletins cover a line of brushless inductor alternators giving complete specifications as well as application data.

CIRCLE 345 ON READER SERVICE CARD

ELECTROMANOMETER SYSTEM Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif., offers a bulletin describing its miniature electromanometer system, a precision measuring device that provides secondary pressure standard accuracies for laboratory, field or industrial applications.

CIRCLE 346 ON READER SERVICE CARD

VIBRATION TESTING Unholtz-Dickie Corp., 2994 Whitney Ave., Hamden 18, Conn. Illustrations, chief features and specifications of a line of vibration test equipment are contained in four-page bulletin No. 8-60.

CIRCLE 347 ON READER SERVICE CARD

SOLID STATE SERVOMECHANISM K-F Products, Inc., 3103 E. 43rd Ave., Denver 16, Colo. A 2-page bulletin illustrates and describes model 122, a general purpose amplifier designed for use with two-phase 60 cps servomotors having shaft outputs of 5 w or less.

CIRCLE 348 ON READER SERVICE CARD

PRECISE ANGLE INDICATOR Kearfott Division, General Precision, Inc., Little Falls, N. J., has published a technical data sheet describing a new high accuracy two-speed precise angle indicator.

CIRCLE 349 ON READER SERVICE CARD

CABLE TIES & STRAPS The Thomas & Betts Co., 36 Butler St., Elizabeth, N. J. Nylon cable ties and straps for securing and identifying wire bundles are described in a new four-page bulletin, TR3.

CIRCLE 350 ON READER SERVICE CARD

SUBMINIATURE SWITCH Micro Switch, Freeport, Ill. Data sheet No. 180 covers in detail the highly sensitive 11SM401 subminiature switch which is designed for use where close control sensitivity or response is mandatory.

CIRCLE 351 ON READER SERVICE CARD

DELAY LINES ESC Electronics Corp., 534 Bergen Boulevard, Palisades Park, N. J. A new 12-page, fully illustrated, facilities brochure, "Advancing the Art of Delay Lines," is available free to those requesting it on their company letterheads.

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Employment Section

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Searchlight Section

460	463	466	469	472	475	478																								
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ALPHA electronic WIRE

- constant flexibility
- cuts time and labor
- outer jacket is replaceable
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- eliminates costly jacket extrusion
- immediate delivery from your local Alpha distributor

For all these benefits, Alphlex Zipper Tubing is used by such OEM leaders as IBM, IT&T, Librascope, Lockheed, Martin, Sperry Rand and Government agencies. Write for free Alphlex Catalog Z-2.

The new Alphlex Closing Tool (above) designed to save you time, labor and money in your cable production requirements is free with each order of 1,000 feet of Zipper Tubing.

TYPES OF ZIPPER TUBING	
ZIP-31	fabricated from .020" polyvinyl sheet made from MIL-I-631C materials. All purpose type for general applications to 105°C. Standard colors: Clear, Black, Yellow.
ZIP-31M	heavy duty construction. Similar to ZIP-31 type except nominal wall thickness of .040". Standard colors: Clear, Black.
ZIP-44	polyvinyl sheet made from MIL-I-7444B materials. Extremely flexible; for aircraft and low-temperature uses to —67°C. Standard colors: Clear (amber), Black.
ZIP-44M	heavy duty construction. Similar to ZIP-44 type except nominal wall thickness of .040". Standard colors: Clear (amber), Black.
ZIP-50	"sandwich" of aluminum foil laminated between two sheets of polyvinyl. For 100% RF shielding applications to 105°C. Standard color: Silver Grey.
ZIP-90	polyvinyl bonded to woven fibreglass sheet per MIL-I-3190A. For rough usage, abrasion resistance, and high temperature uses to 130°C. Standard color: Black.
	All types available in inside diameters from ¼" to 2" in increments of ⅛"; and from 2" to 4" in increments of ¼". Alphlex Zipper Tubing covered by Patents #RE24,613 and #2,558,367 and other patents.

ZIPPER SPECIFICATIONS FOR ALL TYPES OF ALPHLEX ZIPPER TUBING	
Material	Polyvinyl Chloride
Track Thickness (when closed)	.085"
Dielectric Strength, V/mil	700
Tensile Strength P.S.I.	3810
Ultimate Elongation	255%
Operating Temperature, Upper Limit	100°C
Cold Brittleness	—80°C
Fungus-proof	will not support fungus
Flammability	self-extinguishing
Lateral Pull Strength (unsealed)	42.7 pounds/inch
Lateral Pull Strength (permanently sealed)	59.8 pounds/inch
Standard Colors	Black, Clear, Yellow

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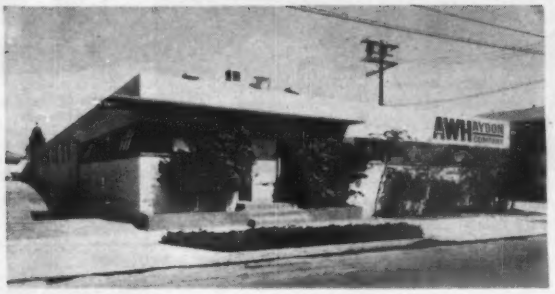

A. W. Haydon Occupies Plant in West

THE A. W. HAYDON COMPANY, which has been manufacturing a line of electrical and electromechanical timers and motors in Waterbury, Conn., has just occupied a new plant in Culver City, Calif.

A new, one-story, 12,000-sq-ft air-conditioned plant, which has adjacent property available for 100 percent expansion, will house management, marketing, engineering and test laboratories in addition to production facilities and support groups. Initially employing 80 men and women, including nine full-time engineers and 13 auxiliary engineers, the plant is intended to service the many major missile and aircraft manufacturers with headquarters on the west coast. Existent sales organizations of the Waterbury plant will sell the new electronic products on the east coast.

Electronic timing devices, as well as test equipment used in quality control, reliability testing, and quality assurance control, will be manufactured in Culver City, supplementing the line of electromechanical timers and motors the company has been manufacturing on the east coast for many years.

Founded as the Technical Development Corporation in 1948, and formed for the production of test equipment by the current chief engineer of the A. W. Haydon Co., the firm was for many years known as Technical Electronics Co., a division of Consolidated Electronics Industries Corp. Haydon has complete facilities for manufacture of a wide range of custom built test devices, as well as a complete line of solid-state timers.

"With the company now offering a full line of timing devices—both electronic and electromechanical—and with sales offices on both coasts, we are in a much better position to offer our customers much faster service and closer coordination between the two engineering groups of the company," A. W. Haydon, president, said.

At the same time, he announced the appointment of John Coulombe as vice-president and general manager of the California plant. Henry Winchel will be vice-president and chief engineer, and Walter A. Beswick will be sales manager.

IRE Announces Fellow Awards

SEVENTY-SIX leading radio engineers and scientists from the U. S. and other countries were recently named Fellows of the IRE by the board of directors. The grade of Fellow is the highest membership grade offered by the Institute and is bestowed only by invitation on those who have made outstanding contributions to radio engineering or allied fields.

Presentation of the awards will be made by IRE sections all over the world wherever the recipients reside. Recognition of the awards will be made by the president of the IRE at the annual banquet on March 22, 1961 at the Waldorf-Astoria Hotel in New York City during the IRE international convention.

Recipients of the Fellow award, which takes effect Jan. 1, 1961, are as follows:

P. R. Adams of ITT Corp., New York, N. Y.; R. J. Adams of U. S. Naval Research Lab., Washington, D. C.; Paul Adorian of Associated-Rediffusion, Ltd., London, England; Pierre Aigrain of the U. of Paris, Paris, France; S. S. Attwood of the U. of Michigan, Ann Arbor, Mich.; G. S. Axelby of Westinghouse Electric Corp., Baltimore, Md.; Samuel Bagno of Walter Kidde & Co., Clifton, N. J.; Vitold Belevitch of Comite d'Etude et d'Exploitation des Calculateurs Electroniques, Brussels, Belgium; F. B. Berger of General Precision, Inc., Pleasantville, N. Y.; G. A. Blake, Maj. Gen., of Pacific Air Forces; R. N. Bracewell of Stanford U., Stanford, Calif.; F. B. Bramhall of Lenkurt Electric Co., San Carlos, Calif.; W. B. Bruene of Collins Radio Co., Cedar Rapids, Iowa; J. S. Christensen of CBS Labs., Stamford, Conn.; J. W. Clark of Hughes Aircraft Co., Los Angeles, Calif.; P. S. Darnell of Bell Telephone Laboratories, Inc., Whippany, N. J.; S. H. Dike of the Dikewood Corp., Albuquerque, N. M.; W. J. Dodds of Bomac Labs., Beverly, Mass.; M. L. Doelz of Collins Radio Co., Burbank, Calif.; W. C. Dunlap, Jr. of Raytheon Co., Waltham, Mass.; R. S. Elliott of the U. of California, Los Angeles, Calif.; Michael Ference, Jr., of Ford Motor Co., Dearborn, Mich.; Richard Filipowsky of Collins Radio Co., Burbank, Calif.; J. F. Fisher of Philco Corp., Philadelphia, Pa.; H. L. Flowers of Goodyear Aircraft Corp., Akron, Ohio; P. F. Godley of Paul Godley Co., Upper Montclair, N. J.; W. E. Gordon of Cornell U., Ithaca, N. Y.; A. R. Gray of The Martin Co., Orlando, Fla.; E. H. Greibach of Greibach Instruments Corp., New Rochelle, N. Y.; D. D. Grieg of Electronic Research Associates, Cedar Grove, N. J.; C. M. Harris of Columbia U., New York, N. Y.; C. E. Hastings of Hastings-Raydist, Inc., Hampton, Va.; L. G. Hector of Sonotone Corp., Elmsford, N. Y.; J. W. Heyd of Monsanto Chemical Co., Miamisburg, Ohio;

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sets up quickly...easy to operate...
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- Dual, self-checking turns counting system
- Loading (wire length) counter
- Core range: ¼" I.D. to 4" O.D. to 1½" high

LABORATORY USE

- Change wire and core size in 45 sec.

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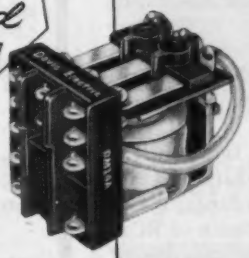

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AMPERITE

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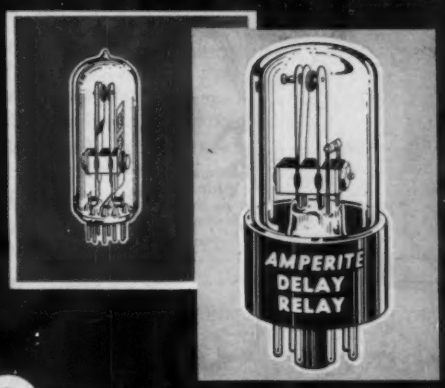

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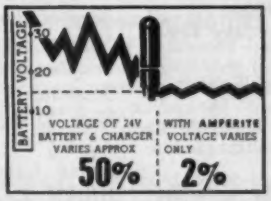
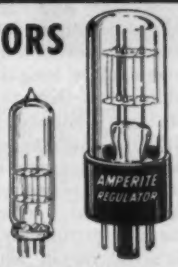
AMPERITE

BALLAST REGULATORS





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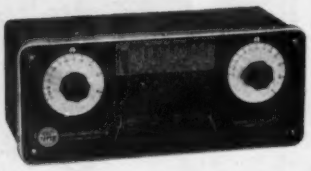
The Allison 201 Continuously Variable Filter



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- Impedance—600 ohms
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John Norton Advances To Technical Director

JOHN M. NORTON has been promoted to technical director in the advanced systems development division of the IBM Corp., White Plains, N.Y.

In his new position, Norton, who has been with IBM since 1953, will direct all the division's technical efforts at laboratories in Westchester and San Jose, Calif.

Wilkinson Assumes New Position

H. MALCOLM WILKINSON has been appointed manager of the data acquisition and logging section of Stromberg-Carlson's electronics division, Rochester, N. Y.

He was formerly in charge of instrumentation systems at Epsco, Inc., Cambridge, Mass.

Stanley Molner Joins Epsco/Medical

STANLEY MOLNER recently joined Epsco Medical division of Epsco Inc., Cambridge, Mass. In his new position as staff engineer, his chief responsibility will be the planning of new products.

Molner is experienced in the application of electronics to medicine and in the design of analog and

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Whatever your immediate or long-range computer requirements, Bryant is equipped to provide "right now" response to your needs for prompt delivery of custom-designed memory drums, standard storage units, read/record heads, and other precision memory system components.

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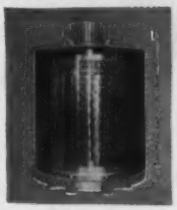
Capacity—20,000 to 2,500,000 bits @ 130 bits per inch . . . **Tracks**—40 to 420 . . . **Speed**—600 to 24,000 rpm . . . **Size**—5" dia. x 2" long to 10" dia. x 19" long . . . **Access time**—As low as 2.5 ms (one head per track).



MASS MEMORY

Capacity—Up to 6,210,500 bits on a single drum . . . **Tracks**—Up to 825 . . . **Speed**—900, 1800 or 3600 rpm . . . **Size**—18.5" dia. x up to 34" long . . . **Access time**—As low as 16.6 ms (one head per track).

BUFFER APPLICATIONS

Capacity—Up to 225,000 bits . . . **Tracks**—Up to 150 . . . **Speed**—Up to 60,000 rpm . . . **Size**—3" to 5" dia. x 1" to 8" long . . . **Access time**—As low as 0.25 ms (4 heads per track @ 60,000 rpm).

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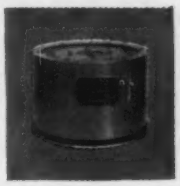

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digital data systems for both industrial and military applications. Prior to coming to Cambridge, he was with Epsco/West, Anaheim, Calif.

Granger Associates Advances Ballard

THE ADVANCEMENT of John W. Ballard to the post of manager of applications engineering at Granger Associates, Palo Alto, Calif., has been announced.

He will assume wider responsibilities for the promotion of company programs in specialized electronic equipment and systems development.

Ballard has been with Granger Associates since last winter on the applications engineering staff.

General Microwave Hires Weitman

IRWIN WEITMAN, formerly with PRD Electronics, Inc., has joined the General Microwave Corp., Farmingdale, N. Y., in the capacity of senior engineer. He will have responsibility for the design and development of proprietary electronic products as well as military equipment in the microwave-electronic fields.

BLH Names Donovan To Important Post

ROBERT M. DONOVAN has been appointed factory manager, electronics & instrumentation division, Baldwin - Lima - Hamilton Corp., Waltham, Mass.

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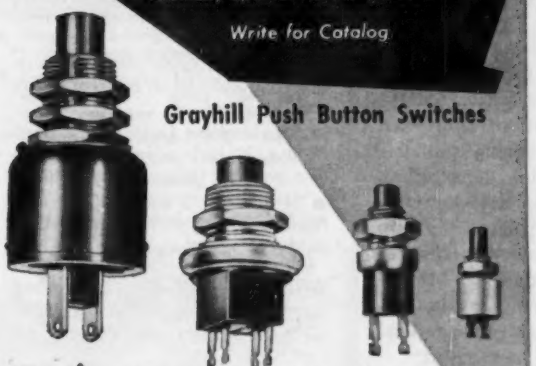

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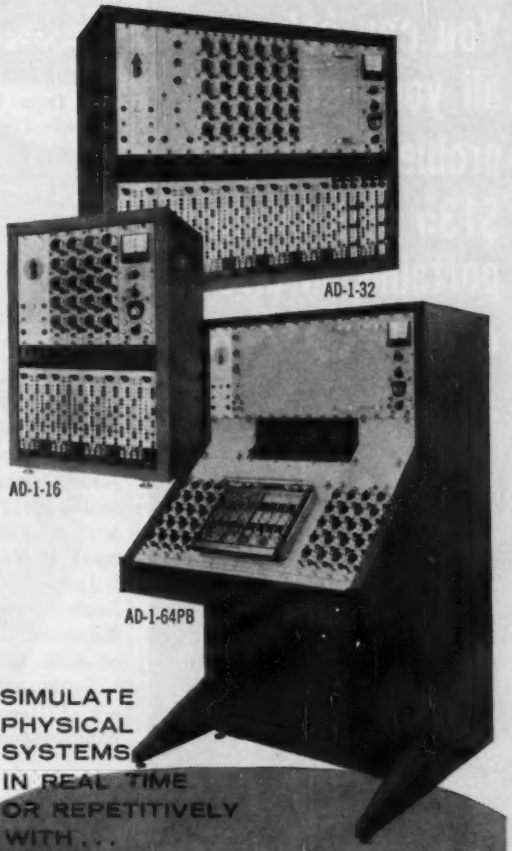

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Modular Design For Plug-In Expandability And Maximum Reliability

- Passive-circuit diode multipliers and function generators
- Computing resistors matched to .01%
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AD-1 Series analog computers are available with from 4 to 64 amplifiers for solution of various types of linear and non-linear equations.

The AD-1-64PB features a removable preprogrammed patchboard with up to 64 stabilized amplifiers, 80 coefficient potentiometers, 16 multipliers, 8 function generators, and 20 diode networks.

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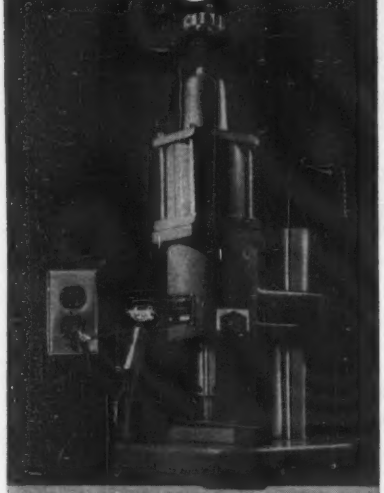

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Donovan comes to the E&I division from the Madsen Works of Baldwin-Lima-Hamilton, La Mirada, Calif., where he was factory manager for the past five years.

Sanborn Gets Award For Hiring Handicapped

SANBORN CO., Waltham, Mass., was honored recently for its outstanding record in employing the physically handicapped.

The Associated Industries of Massachusetts Award was presented by the Massachusetts Governor's Commission on the Employment of the Handicapped.

James L. Jenks, Jr., president of Sanborn, accepted the award from Raymond H. Blanchard, president of AIM.

Sanborn has about 1,000 employees. Fifteen percent are physically handicapped.

Lockheed Electronics Ups Schaeffer

ROBERT W. SCHAEFFER, who joined Lockheed Electronics Co., Metuchen, N. J., in April of this year, has been appointed acting manager of the field evaluation department, engineering services division. He will direct the activities of a group of technical personnel who furnish the military and industry with independent engineering evaluation of electronic and electromechanical systems.

Before assuming his new duties, Schaeffer served as a staff assistant to R. D. Chandler, Jr., assistant general manager of the engineering services division.

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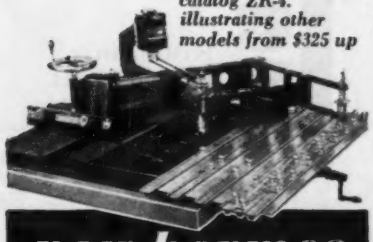

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(Continued on pages 140-141)

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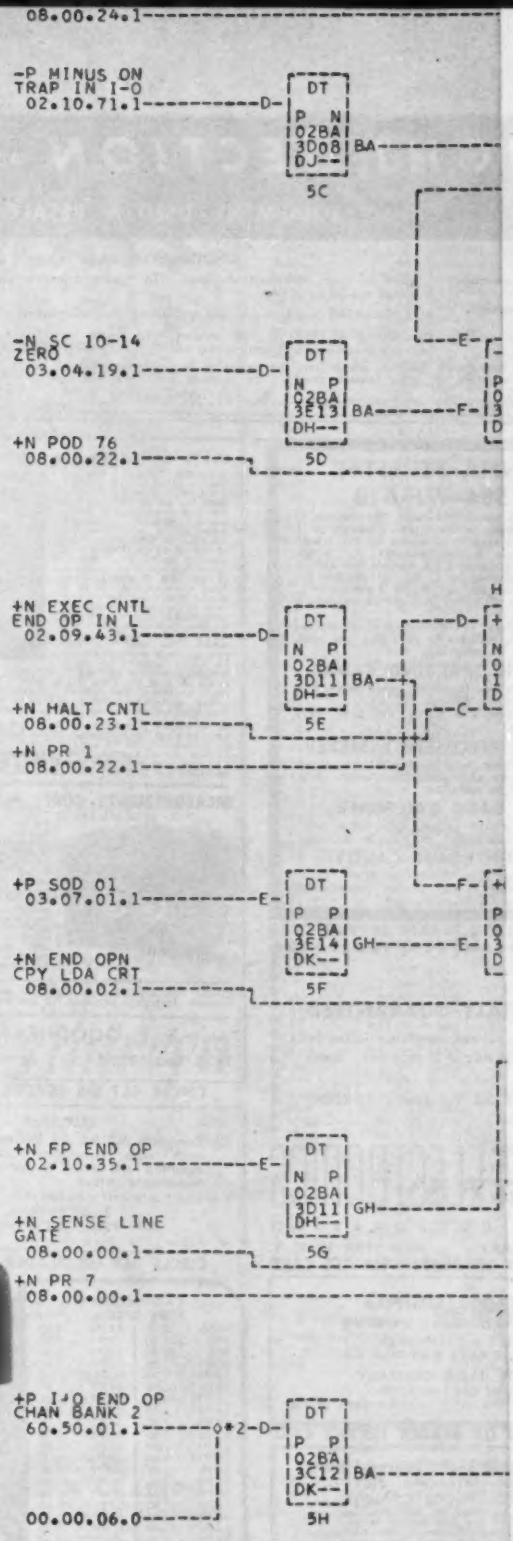

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This circuit design was printed by a computer.

IBM engineers did the creative work, specifying the logic functions desired and the circuits that would do the job most efficiently. The machine then checked this design. After the errors had been corrected, the computer determined the proper panel wiring, weighing such parameters as inductive noise, lengths of wires in alternative routes, and types of wires.

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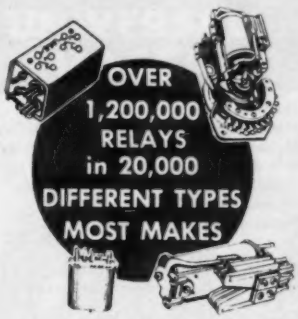

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2C43	6.50	C6J	12.50	417A/5842	10.00	5665/C16J	25.00	6072	1.75
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2C51	1.50	6J6W	.60	420A/5755	5.00	5675	7.50	6080	3.00
2C52	1.50	6L6GAY	.75	421A/5998	7.50	5676	1.25	6080WA	4.00
2D21	.50	6L6WGB	1.75	422A	10.00	5678	1.25	6080WB	10.00
2D21W	1.00	6Q5G	2.50	423A/6140	5.00	5684/C3J/A	11.80	6082	3.50
2E24	2.50	6SJ7WGT	1.00	429A	9.00	5686	1.85	6087/5Y3WGTB	3.00
2E26	2.50	6SL7WGT	.75	450TH	30.00	5687WA	2.50	6099	.75
2E30	1.85	6SN7WGT	.50	450TL	30.00	5691	5.00	6100/6C4WA	1.25
2J42	35.00	6V6GTY	.75	575A	12.50	5692	2.00	6101/6J6WA	1.00
2J51	75.00	6X4W	.75	631-P1	5.00	5693	4.00	6111A	2.00
2K25	8.50	6X5WGT	1.00	673	12.50	5696	1.00	6112	2.50
2K26	25.00	7MP7	17.50	676	27.50	5702WA	2.75	6115/QK-351	40.00
2K29	25.00	10KP7	15.00	677	27.50	5703WA	3.00	6130/3C45	8.50
2K30	75.00	12AT7WA	1.40	714AY	10.00	5704	1.00	6136/6AU6WA	1.25
2K34	75.00	12AY7	1.00	715C	10.00	5718	1.00	6137/6SK7WA	1.50
2K35	250.00	HK-24	1.00	719A	7.50	5719A	1.50	6146	3.50
2K41	25.00	25T	7.50	721B	3.00	5720/FG-33	17.00	6152	4.50
2K42	125.00	26Z5W	1.25	723A/B	2.50	5721	125.00	6186/6AG5WA	1.50
2K43	125.00	35T	7.50	725A	7.50	5725/6AS6W	1.00	6189/12AU7WA	1.50
2K44	125.00	35TG	2.50	726B	3.25	5726/6AL5W	.60	6197	1.75
2K47	125.00	FG-105	17.50	750TL	87.50	5727/2D21W	1.00	6198	85.00
2K50	65.00	FG-172	17.50	BL-800A	50.00	5728/FG-67	7.50	6199	35.00
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3AP1A	7.50	244A	2.50	804	15.00	5744WA	2.75	6202/6X4WA	1.50
3B24	.35	245A	3.50	805	3.00	5749/6BA6W	.75	6211	.65
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3B25	3.00	249C	5.00	810	12.50	5751/12AX7W	1.35	6236	150.00
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3C22	25.00	254A	2.00	814	1.50	5778	125.00	6265	2.25
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3C45	3.00	262B	3.50	828	7.00	5787	2.50	6336	9.50
3D22	8.00	267B	7.50	829B	7.75	5799/VX-21	3.00	6352	8.50
3E29	3.50	271A	10.00	832A	6.00	5800/VX-41	3.50	6364	150.00
3J21	35.00	272A	4.00	836	1.00	5801/VX-33A	3.00	6390	150.00
3J31	50.00	274A	2.50	837	.90	5802/VX-32B	3.50	6438	4.00
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3K27	150.00	293A	4.50	884	1.00	5828	3.00	6544	250.00
3K30	50.00	300B	5.00	913	8.50	5829WA	1.50	6550	4.25
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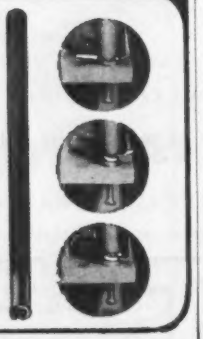

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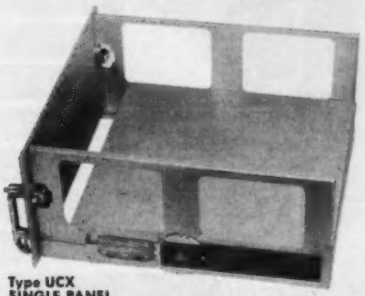

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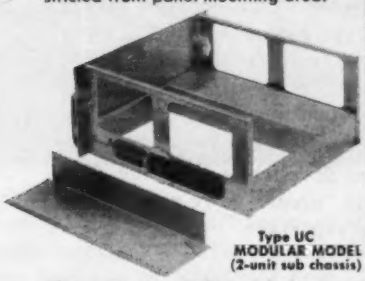

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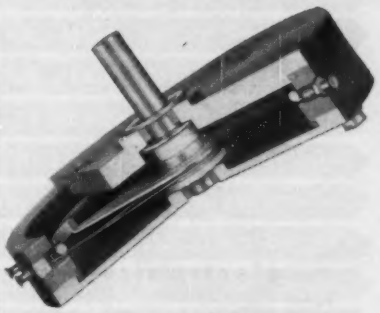

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52, Not 53

ELECTRONICS magazine is dated Friday each week. 1960 contains 53 Fridays, a situation which occurs every few years. To those among us used to a 52-week year, this 53rd Friday is mechanically awkward.

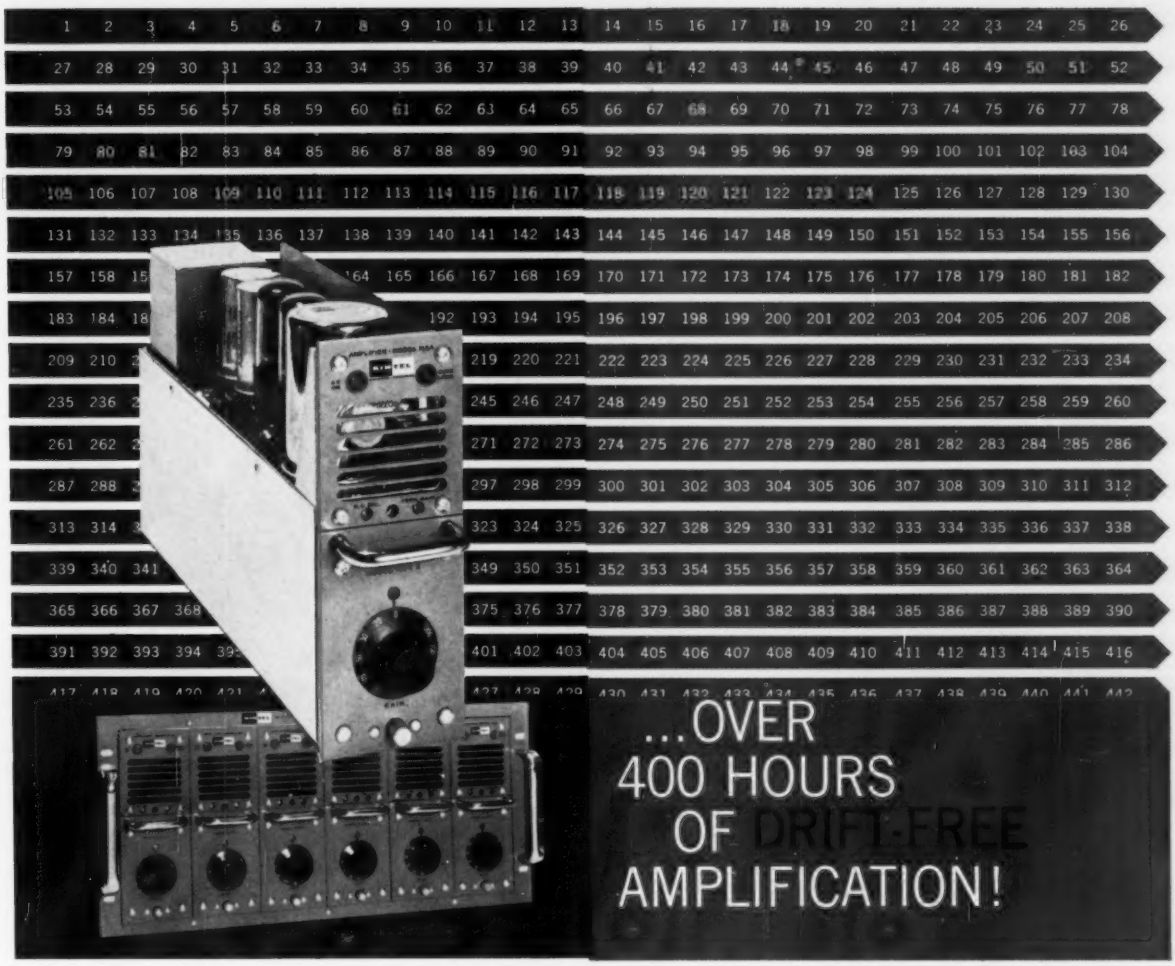
Hence the decision to publish only 52 regular weekly issues of ELECTRONICS this year regardless of the number of Fridays. There will be no issue of December 30, 1960. Subscribers will receive the issue of December 23, 1960, and their next copy will be that of January 6, 1961. And, since our statistics indicate an average reading time of one hour and 22 minutes per issue, may we suggest that you use this "break" to re-read one or more of our special editorial reports:

The Electronics Market—January 1, 1960
Electronics Research & Development Around the World—February 12, 1960
What's New in Electron Tubes—April 29, 1960
Electronics In Japan—May 27, 1960
Modern Microwaves—June 24, 1960
Electronics Probes Nature—July 29, 1960
Electromechanical Devices and Systems—September 30, 1960
Microminiaturization—November 25, 1960

or that you study again our 1960 Buyers' Guide and Reference Issue. Glance through the pink pages in particular. We believe you will convince yourself that the new EBG is greatly enhanced in value and more than ever before the indispensable catalog–directory and reference source it has been for twenty years.

James Gilwood

PUBLISHER



Less than 2μv of drift for over 400 hours of continuous operation! That's just one of the many outstanding features of KIN TEL'S new 112A wideband DC amplifier—the unit that is the successor to KIN TEL'S 111 series DC amplifiers. Frequency response is from DC to beyond 40 kc, output capability up to 45 volts. It has an integral power supply, fits the same cabinets and modules, and can be used to replace any KIN TEL Model 111 amplifier.

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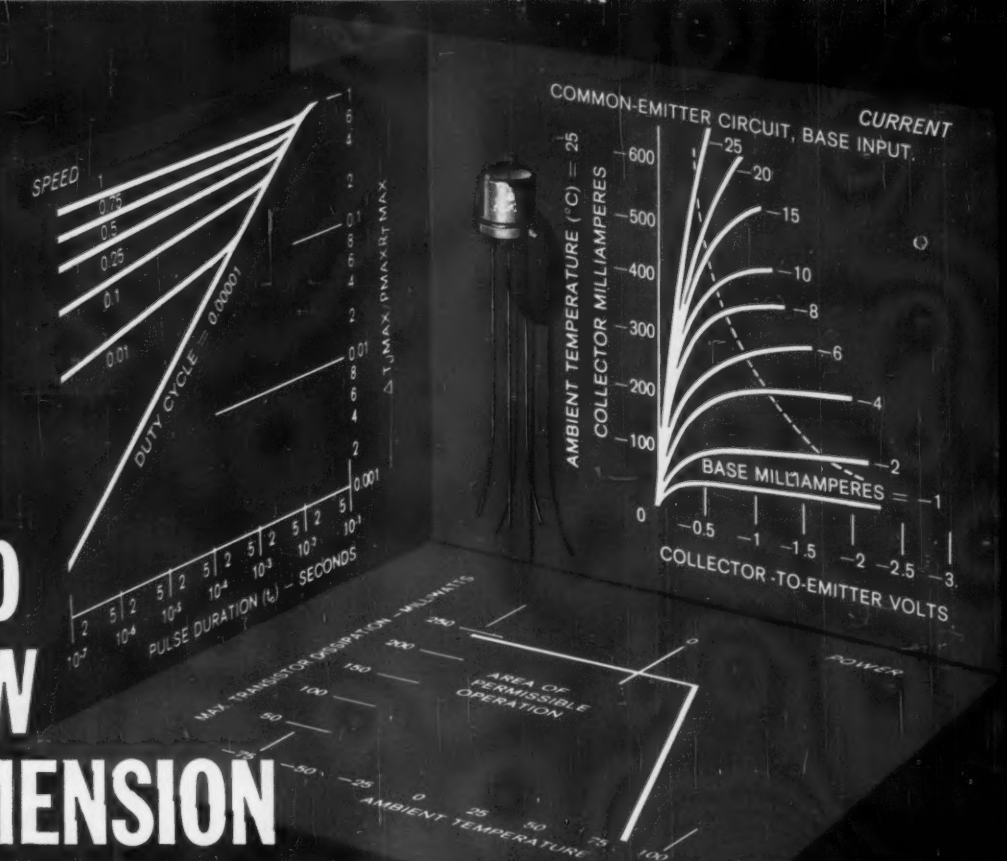

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Maximum Ratings, Absolute-Maximum Values:	
COLLECTOR-TO-BASE VOLTAGE	−30 max. volts
COLLECTOR-TO-EMITTER VOLTAGE	−30 max. volts
EMITTER-TO-BASE VOLTAGE	−1 max. volt
COLLECTOR CURRENT	−500 max. ma
EMITTER CURRENT	500 max. ma
TRANSISTOR DISSIPATION:	
At an ambient temperature of 25°C	240 max. mw
At an ambient temperature of 55°C	120 max. mw
At an ambient temperature of 71°C	56 max. mw
AMBIENT-TEMPERATURE RANGE:	
Operating	−65 to +85 °C
Storage	−65 to +85 °C

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